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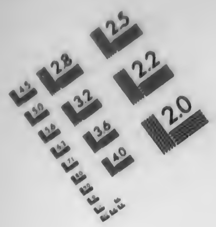

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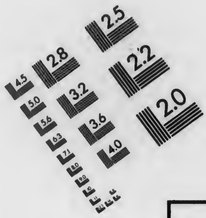

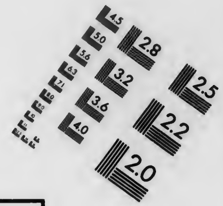

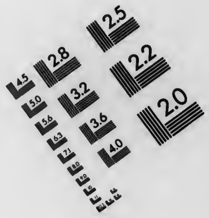

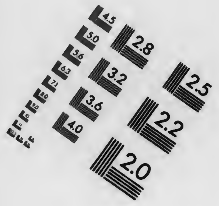

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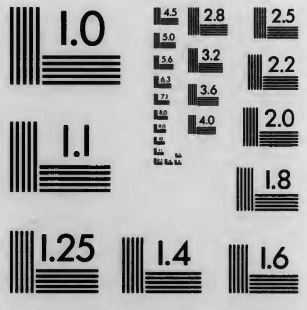

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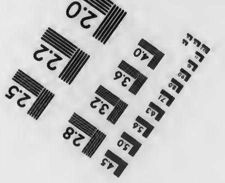

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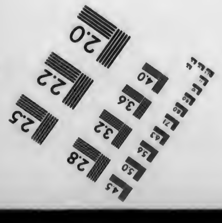

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THE COLLEGE OF ENGINEERING,
THE COLLEGE OF COMMERCE AND ADMINISTRATION
AND
THE DEPARTMENT OF PSYCHOLOGY
OF
THE OHIO STATE UNIVERSITY

IN COOPERATION WITH

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PREFACE

Following the precedent created in 1925, the Bureau of Business Research has edited for publication the papers presented on business and industrial management during Management Week at Ohio State University, which was held October 28 and 29, 1926.

While the editors do not assume responsibility for the opinions expressed in this publication, they have endeavored, with the assistance of the authors, to make the papers complete and clear on the issues discussed.

SPURGEON BELL, Director,
Bureau of Business Research

CONTENTS

Page

AN ANALYSIS OF SOME CURRENT METHODS OF FORECASTING THE TREND OF BUSINESS 1

THE USE OF INTEREST RATES AND PRICES IN FORECASTING BUSINESS 20

RECENT ADVANCES IN ECONOMIC SCIENCE IN THE STUDY OF PRICE TRENDS 34

THE RELATIONSHIP BETWEEN INDUSTRIAL EMPLOYMENT AND DEPARTMENT STORE SALES IN OHIO 49

FORECASTING GENERAL BUSINESS CONDITIONS 66

AN ANALYSIS OF SOME CURRENT METHODS OF FORECASTING THE TREND OF BUSINESS

By

C. O. Hardy, Institute of Economics, Washington, D. C.

(THURSDAY MORNING SESSION, October 28, 1926)

Professor Spurgeon Bell, Presiding

Chairman Bell: As you know, this is a meeting of the statistics section of the Ohio Conference of Statisticians. Dr. Merchant, of Dayton, is the president of the Conference and the program for the business statistics section was turned over by him to Mr. Morris and Mr. Wills and myself and we have arranged for the meeting here today.

I should like, however, to hear from Dr. Merchant if he has anything in mind for the good of this section.

Dr. Merchant (President, Ohio Conference of Statisticians, Dayton, Ohio): I'd just like to say that we organized this conference of statisticians in April of this year and this is the first meeting we have had since that organization. We would like to get any person anywhere in Ohio or any nearby state who is interested in this subject to become a member of this conference. We hope to put on one or more meetings of this character each year and stimulate interest in the study of statistics as much as we can.

We might say that practically all the work that has been done for this organization has been done here in Columbus by these men at the University who are especially interested in promoting this subject. During the course of these meetings, if any of you would like to become members, we would like to have your names. The membership fee is one dollar.

Chairman Bell: Something was said at the time the statistics group was organized and the business section was organized about the advisability of organizing local statistical groups in the various cities of Ohio and I wish to refer to that at this time just for the purpose of indicating my interest in that and indicating the interest the Conference would have in it. We are particularly interested in keeping in touch with statistical groups in the state of Ohio. I know it is anticipated there will be in Columbus within the near future a statistical group comprising a certain number of people at the university who are interested in that subject and a certain number of people down town who are interested in keeping in touch with the progress of statistical investigation and the progress of research in the field of business statistics. And, if any of you have such an organization at some other place or anticipate the creation of such an organization, it will be a great pleasure to me to know about it because I would like to get the benefit of the work of these groups and the general scope of interest of these groups. That would have a bearing on the activity of our own statistical organization here at The Ohio State University.

Many of you already know about Dr. C. O. Hardy. Dr. Hardy was formerly connected with the University of Chicago, where he taught the subject of investments, and he is the author of the book, "Risk and Risk-bearing," which treats to some extent the question of forecasting the trend of business, but he is also author of a book to be published in January, now in the galley proof, on the subject of forecasting, in which he reviews the scientific activity in the field of forecasting in this country. At the present time he is connected with the Institute of Economics in Washington and is also connected with the Brookings School, a graduate school of research in the field of economics and political science. It is a pleasure to introduce Doctor Hardy.

Dr. C. O. Hardy (Institute of Economics, Washington, D. C.): Before I say anything about business forecasting I wish to make acknowledgment of indebtedness to Professor Garfield V. Cox, of the University of Chicago. Professor Cox and I are collaborating in preparing the book to which Mr. Bell has just referred, and I have drawn very freely upon his materials in preparing for this discussion.

The interest in business forecasting has been a thing of very rapid growth since the World War. Twenty years ago there was only one commercial agency in this country engaged in rendering specialized service in business forecasting, and that agency was in its infancy and little known. Today there are more than half a dozen such agencies, each of which has a national clientele, many large corporations have established special forecasting departments, and a number of universities have departments of research. All these have been factors in the large increase in the amount of attention paid to the subject.

This increase in attention is due, in a large part, to the very rapid changes in prices and shifts in business conditions which characterized the war period and the period since the war. It is due also to the extraordinary advertising ability of Roger Babson's organization. Whatever may be your opinion as to other aspects of Mr. Babson's work, his publicity department has been extraordinarily efficient and has very thoroughly sold to the business men of the country the idea that there is such a thing as a business cycle, an idea that was relatively new even to academic men at the time his sales campaign started—a cycle rather than an irregular succession of crises.

There are those both in business and in academic life who from the first have remained skeptical of business forecasting and distrustful of forecasters, some because they questioned the adequacy of our present knowledge of the nature of the business cycle as a basis for rational forecasting, others, still more skeptical, because of doubts as to the existence of such regularities in the ebb and flow of business as would enable one to make valid forecasts even if they were completely understood.

I don't believe any of the guild of forecasters believe that forecasting affairs is a science in any such sense as the prediction of tides and eclipses or even the weather. It is not scientific in the sense that it rests on scientific laws whose operation can be stated accurately and the subject matter of which can even be accurately observed. We can't define the human group action in any way to make universally valid forecasts. Moreover, the conditions with which we have to deal are never twice alike. The conditions with which we have to deal in forecasting are only approximately like those from which we derive the principles.

Finally, even if we had precedents to guide us into a sound and adequate theory, we would still have no certainty that we had all the facts necessary to an application of the theory to a given situation. We must always judge the whole from a sample.

These are obstacles to scientific prediction in the academic sense but they are no more staggering than are the uncertainties with which business men must constantly deal. They are certainly reasons why we should qualify our forecasts and not be too dogmatic, and they always furnish us an alibi in case the forecasts are unsuccessful.

Two positions may be clearly distinguished among students of forecasting. One group believes that the observed sequence of certain changes in past fluctuations of business activity is sufficiently regular to justify the expectation that such regularity will persist during the near future. This view stresses the rhythm of business activity. Adherents of the second position place little confidence in such an established rhythm and emphasize the factors which make each situation essentially different from all preceding ones. In their view, the prediction of economic events is possible only to the extent that we can reason from known causes to anticipated effects—specific forecasts can be justified only on the assumption that the important forces operating in a given situation can be identified and each given its correct interpretation and proper weight.

Now, among the first group, those who believe that history repeats itself with sufficient regularity so we can prophesy on the historical basis which, of course, is the thing that brings the statistics into this, again you can distinguish two viewpoints, if not more. One is the simple proposition that when business is above normal, it is certain to react and that when it is below normal, it is certain to recover. Reliance upon this principle as a basis for forecasting obviously implies confidence that for any given period it is practicable to determine what constitutes normal activity. That, of course, implies that you have some confidence in your ability to determine what is normal.

A second and very influential group of business forecasters (and I will tie these distinctions up with specific agencies in a moment) does not lay stress on the question whether you are above or below normal but urges that there is a certain sequence which can in general be relied upon. Of course, as most of you know, that is a sequence between money rates, general business activity, and the swings of the stock market with various things fitted in the sequence with more or less accuracy. There is a pretty general agreement on the broad outline.

The second view lays much less stress upon the relation of observed activity to "normal." It is urged, rather, that changes in certain types of economic activity tend to anticipate or to lag behind changes in others, with dependable regularity. This regular anticipation of one phenomenon by another is not necessarily regarded as evidence of casual connection. It is only claimed that, since this relationship has persisted in the recent past, it is reasonable to expect it to continue for at least the near future. If this expectation is justified, one can forecast changes in the degree of business activity by watching the behavior of factors which change in advance of one another, even though he may be unable to identify the causes of these changes.

These different underlying assumptions give rise to different methods of forecasting. The theory of regularity in the succession of economic events suggests what we shall call the method of historical comparison. Historical data are examined in order to pick out typical sequences, and forecasts are made on the hypothesis that history will repeat itself. On the other hand, the belief that each situation is different from preceding ones and that the forces making for change may be identified, interpreted, and measured, calls for the use of what we shall call the method of economic analysis. Specific forces at work in a given situation are studied with a view to forecasting their probable consequences.

In practice, while different services have laid down very different principles, neither the method of historical comparison nor the method of economic analysis has long been followed to the complete exclusion of the other. However great the similarity between corresponding phases of successive business cycles, the differences are yet great enough to cause trouble sooner or later for any one who ignores them. Those who have undertaken prediction on the basis of historical comparison have come increasingly to modify their conclusions in the light of the special factors that differentiate the situation in question from the more or less similar ones that have preceded it and have found the forces making for change were so obscure that they have fallen back on the other method.

I think that tendency for the extremes to draw together is one of the most striking things in the history of business forecasting in the last seven years. The prominent business forecasting agencies usually are still standing in theory on the ground where they started to work at least seven years ago but in practice they all show the influence of one another's work.

I want to discuss in some detail four well known forecasting agencies: Babson's, Brookmire's, Harvard Economic Service, and the Standard Statistics Company; with some reference to various other forecasting agencies but principally those. Classifying them in the way I have just done, you find Babson at one extreme and Standard at the other. The theory of the Babson Service is a very extreme historical sequence theory—action follows reaction, reaction follows action—without any far-reaching analysis of the causes why that should be true.

On the other extreme I should put the Standard Statistics Service and such forecasting as the National City Bank Letter or Benjamin Baker's column in "The Annalist," which pay little attention to the generally accepted categories of the business cycle and talk in terms of what are likely to be the result of the things they can see going on at the moment.

Before discussing these services, however, we must give attention to certain questions of technique. The raw materials with which the student of business conditions must work consist almost entirely of statistical series. Series relating to past business cycles are analyzed in order to discover typical sequences and formulate principles of general applicability; while series relating to the present and the immediate past are the most important data to be used in making practical application of the forecaster's theoretical knowledge. Some information comes in the form of general knowledge concerning the state of trade, the efficiency of labor, the attitude of the speculative public, the political outlook, and other conditions which cannot be reduced to the form of numerical items, and that is quite as true whether you are using an historical sequence technique or working on the basis of cause and effect.

Comparisons of series are usually made in one of two ways. The simplest method is a comparison of the cyclical turning points. In a single series the interval from peak to peak and from peak to trough may be noted, in order to determine the typical length of the cycle in a given phase of economic life. The interval from the peak of one series to the succeeding peak, or trough, of another series is studied to bring out typical sequences which may serve as a basis either for empirical forecasts, or for conclusions with regard to causes and effects.

The other method, which is much more precise, consists of a measurement of the degree of correspondence between the series by means of the Pearsonian coefficient of correlation, with varying degrees of lag in the one series behind the other. This method was used first by English economic statisticians, and was introduced into this country in its application to economic data by Professor H. L. Moore.

Now, obviously, if you are going to make any direct comparison

of series for the purpose of studying the cycle, you have to get rid of disturbing elements which have to do with the cycle. Most conspicuous are the seasonal variation and secular trend. I shall not stop on seasonal variation except to say, in my judgment, there is no satisfactory method of eliminating seasonal variation. For a good many purposes, it isn't necessary to eliminate it. It is, in my judgment, eliminated in a good many cases where it isn't necessary unless you want to use the data for some other purpose. For instance, if you want to figure the correlation of two series without any lag for a fairly long series, obviously if only one has a seasonal variation or if the seasonal variations are totally different, it is not necessary to take account of this factor, but if there is any correspondence between the variations, they must be gotten rid of, and you can't do it except approximately. Of course, one of the big contributions of the Harvard Economic Service has been the development of relatives derived from medians. These are difficult of calculation but the method found general acceptance as the most satisfactory method. In recent writings various other methods have been suggested. I believe that research along that line will give us something better in the years to come. Remember we are at an early stage in that branch of statistical research.

With regard to secular trend, the case is somewhat different. Supposing for your purpose all you need is comparison of turning points. For that purpose the seasonal variation makes a tremendous difference, but the secular trend rarely makes any difference. A cycle measured from any reasonable trend or as measured without any trend will nearly always come out the same anyway. For purposes of correlation, the trend makes a good deal more difference than does the seasonal trend; in a direct comparison of turning points it works the other way around.

The development in the last six or seven years of precise mathematical methods of fitting curves is another post-war development for which we are indebted to the Harvard Service. The one thing I want to emphasize with regard to trend is the importance of confininig the trend within its own limits. The professional forecasters have not, as a rule, attempted to make forecasts any distance ahead by projecting the trend but there have been published a number of forecasts of railroad traffic and prices ten or fifteen years ahead, made by figuring the trend over a chosen period in the past and projecting it. In my judgment that is one of the most misleading statistical devices we have as can be seen if you fit two or three different curves to the same data, you will get totally different forecasts, without anything on which to base a decision as to which is the better trend.

Now we will turn to these services. The Babson Statistical Organization is the oldest and probably the best known of the specialized services. Its forecasts are said to be based primarily upon the assumption that "the law of action and reaction applies to economics and human relations, en masse, as it applies to mechanics." "To every action there is always opposed an equal reaction" in business activity as truly as in the realm of physics. In the Babson forecasting this hypothesis is graphically called the "area" theory. It holds that every period of supernormal business activity must inevitably be followed by a period of subnormal activity, the product of the duration and the intensity of the excessive activity being equalled by the product of the duration and the intensity of the succeeding depression. To measure the successive areas of over-expansion and depression, three steps are necessary. First, there must be chosen a number of statistical series of sufficient economic importance to represent adequately the general business situation. Second, a method must be employed which will combine these series into a single composite index of business activity. Third, the degree of activity which constitutes normal must be determined for each successive period.

Turning to the first problem, that of a choice of subjects, we note that the business value index is now made up of the following subjects: the value of building permits in 20 principal cities; total liabilities involved in business failures; check transactions as reported by the Federal Reserve Banks; dollar value of exports and imports; foreign money rates (an average of the official rates of the central banks of England, France, and Germany) ; rate of commercial paper at New York; volume of crops of corn, wheat, and cotton; gross earnings of railways; Canadian business conditions; and stock prices.

All the items which are expressed in dollar values are corrected by dividing by an index of prices. The method used in combining these is unique and is too complicated for discussion here. There is also an older index which is not corrected for prices, which has been published until very recently. The two have been used alternately but I believe it is the intention for the present, at least, to rely on the "deflated" chart. In both charts the normal line X-Y is computed from the volume of check payments, and depression and prosperity are measured from this time.

For forecasting purposes the method of interpreting both of the charts is the same. The size, though not the shape of a given area of depression, can be predicted from the magnitude of the previous area of prosperity. If an area above the "X-Y" line should start to form before a depression area approximately equal to the preceding area of prosperity has developed, the recovery is destined to be short-lived and followed by a relapse. When, however, an area of depression has been completed and the business index rises above normal, the size of the preceding area of depression offers no clue to either the shape or the magnitude of the developing area of prosperity.

These 11 or 12 items, which, in view of a great many students of business conditions, should be sub-grouped in some way because they follow one another rather than run concurrently, are all thrown together. That is one important contrast with the Harvard and Brookmire Service. The Babson chart, for example, throws interest rates and pig iron and stock prices together, whereas it is the contention of Harvard and Brookmire that one forecasts another and the composite is rather meaningless.

Babson also makes use of the method of historical sequence. According to the "Barometer Letter," the high points of the stock market have come in the early part of the over-expansion areas, while the low points have come in the early part of the depression areas. Low money rates and high bond prices have usually come about the end of the depression areas, and high money rates and low bond prices at about the end of the over-expansion areas.

Another method frequently employed is that of specific historical analogy, picking out some period in the past and comparing it with the present. From 1919 to 1922 the Babson Service frequently drew a parallel between the commodity price situation after the World War and that which followed the Civil War. And, on one occasion comparison was made between the trend of prices in 1817 and that which should be expected in the closing months of 1919.

Still more frequent, particularly of late, has been the use of economic analysis. The fundamentals of the situation are usually not exhaustively described, but two or three factors are cited as working toward certain effects, and the impression is left that these are thought adequate to determine the trend of business for the near future.

An example of more thorough economic analysis occasionally occurs, as for instance in the summer of 1922. In spite of the fact that the depression area was little more than half as large as the previous area of expansion, it was stated that the short-run prospect was for business above normal. Five fundamental factors were discussed, each of which was said to indicate a revival: (1) habits of extravagance and waste had been largely abandoned; (2) the 1922 crops promised increased income to the farmers; (3) loanable funds had become abundant; (4) inventories had been written off, stocks of goods cut down, and indebtedness to banks greatly reduced; (5) the rise in security prices made the cost of new financing no longer prohibitive.

Certainly the tendency of the Babson device is to broaden out the range of things it takes in. Their statistical technique is considered by their competitors to be crude, and a great deal of fun has been poked at the "area" theory, largely because of the dogmatic form in which it is stated. Nevertheless, it isn't very different, when you strip it of verbiage, from what a great many highly reputable economists have said using the terms over-production and under-production, above-normal and below-normal, and other less extreme pharseology.

The Brookmire Economic Service also places conspicuous emphasis upon forecasting by means of what we have called historical comparison. Unlike the Babson organization, however, it does not assume that there is an inherent and predeterminable limits to the magnitude of any given movement of business activity. It relies instead upon two theories: first, that supernormal activity is certain to subside and subnormal activity to revive, and, second, that major reversals in the trend of various financial and business factors tend to occur not simultaneously but in a definite sequence.

Before the war the founder of the Brookmire Service had arrived at the generalization that the beginning of an upswing of a business cycle is marked by the rise of an index of potential bank credit, followed within a few months by a rise in security prices, the latter, in turn, being followed by an expansion of general business and a rise in commodity prices. This, in turn, is soon followed by a decline in the banking index which foretells a decline first of the stock market and then of general business. This decline finally is followed by a rise in the banking index which is considered to mark the first stage of a new cycle.

Now, that sequence has come to be so commonly known that it is hard to realize that it isn't many years since it was quite unfamiliar and that the Brookmire people were the discoverers, or at least the first to give it wide publicity. The Harvard Service made a much more elaborate investigation but arrived at practically the same sequence that the Brookmire people had arrived at before the war.

Brookmire's sequence theory is not used as much as it was years ago. The service has shifted to the other principle that business can be figured out to be above or below normal at a given time. When above, it is a bearish symptom; vice versa, the further below normal, the nearer the end of the depression. They have an interesting mechanical device known as Barometer No. 9. This is a statistical compilation gotten up on the principle of throwing together series of past data in such a way that they would have forecast past business activity. The forecast is not worked from a theory of what ought to happen. The effort is simply to weight the service so as to get a combination that would have given you the best forecast. Then you combine them with these weights as a forecaster of the future. If it won't work you make such modifications as are needed. It is very easy to combine series so that you can get a past forecast of past events. If, having done that, the sequence holds in the future, you have made an important contribution to economic science. If it doesn't hold, you try again. (Laughter)

Barometer No. 9 consists of indexes of the volume of domestic goods coming into the market, ratio of imports to exports, turnover of bank deposits and commercial paper rates. These are variously measured. For instance, production of goods is a combination of pig iron production, steel ingot production, cotton consumption and lumber production. There are others that have been dropped out. These are combined in such a way that any advance above what is regarded as normal is a bear factor; the higher the item goes when it is already above normal, the lower the index goes.

An element of economic analysis is involved in almost every Brookmire forecast, for it is customary to analyze separately, as a factor making for business improvement or recession, each subject which is used in the composite index. Many factors outside the index are also brought from time to time within the scope of this process. The effect of the crops upon the business outlook is occasionally considered, and political factors are also discussed. The latter are held, however, to do no more than slightly to add to or detract from the fundamental economic movement that chances to be under way at the time. Other factors frequently given attention are: disparities between the prices of different classes of goods, adequacy of transportation facilities and of labor supply, foreign economic and political conditions, and the degree of business confidence which, of course, we recognize is difficult to measure.

The Harvard Economic Service is newer. The investigations on which it is based were published in 1919. The investigation covered a very large number of series, some 20 or 30, correcting them carefully for secular trend and seasonal variation, then measuring the lag of one behind the others and grouping them then into those items which tend to run together and to forecast other groups. Then, when that was done, the technique was further developed. You first put together all that run together. Then you eliminate items that seem to be superfluous. Obviously, if a group of six items will forecast the movement of community price and you find by leaving out two you get the same result, there is no advantage in including them so long as you are working on an empirical basis anyway.

Of course the Harvard contribution to the statistical field has been very large. They publish more detailed reproductions and have had a very large influence on the methods of other agencies as well as other types of research.

As has been noted, the Harvard Economic Service depends to a large extent upon its anticipation that certain phenomena will follow one another in the way they have followed in the past. Some of the significant results of their investigation of the past history of economic fluctuations are summed up in their "Index of General Business Conditions." As at present made up, this chart includes bank debits, stock prices, commodity prices, and money rates. Curve A, speculation, represents New York bank debits and industrial stock prices; Curve B, business, includes outside bank debits and commodity prices, and Curve C, banking, is based upon commercial paper rates.

This is the thing which they have emphasized. Nevertheless, they do not confine themselves to this particular technique. Their forecast for 1920 and 1921 was brought out in the form of a comparison of conditions at the beginning of 1920 with 1906.

Repeatedly during the early months of 1926 it was pointed out that the index of production in basic industries had risen much higher than the index of production of consumers goods, and the reader was reminded that repeatedly, since 1919, such a spread between these indexes had proved a forerunner of curtailment of basic production and of general manufacture. It was also emphasized that in recent years the appearance of weakness in the price of raw materials such as steel scrap, zinc, copper, hides, and wool, at a time when manufacturing activity was well above normal, had quite regularly preceded decline in industrial production, and that the recession in prices had combined until the rate of basic production had been substantially reduced. Stabilization and recovery in the prices of these sensitive commodities had, in turn, preceded the recovery of general price indexes and the revival of activity in basic industries.

The spring of 1926 affords a good example of the use of economic analysis. Although the situation was interpreted primarily in the light of typical sequences and analogies with recent situations, a number of special factors were pointed out as differentiating the current situation from preceding cases. Among these factors were the increased quantities of goods sold on installment, the heights to which security and real estate speculation had been carried, the fact that the building shortage was now more nearly made up than at any time in years, and the increased uncertainty as to the ability of the market for automobiles to maintain the industry at the existing level.

During the past three years the forecasts of the Harvard Service have been influenced very strongly by the theory that we now have a "regulated" business cycle. In other words, in common with a considerable number of other students of business conditions, the staff of the Service believe that since 1923 the Federal Reserve Board, and other public agencies, have been exercising so direct a control over credits and so great an influence over public sentiment, that the length and intensity of the successive phases of the cycle have been modified and the pre-war sequences to some extent broken down.

The Standard Trade and Securities Service and its predecessor, the Standard Daily Trade Service, go to the other extreme of practically cutting out the business cycles as such and the sequences and analyzing in terms of the factors that they can discover at work. They are not quite the other extreme, though. You have to go to some paper such as the forecasts in "The Annalist" to get the extreme. But, in an address delivered in 1925, the editor of the Standard Trade and Securities said:

"We use the term cycle only in the sense of a unit of measurement—from one peak to the next, or from one trough to the next. Thus, in our minds, we strip the idea of any inevitability or of any measurable periodicity. Abnormal production cannot indefinitely endure any more than can subnormal production. But, there is no reason why normal production cannot be sustained. Therefore, every time that production begins a new cyclical upward swing, let us say, we regard it unsafe to forecast that this swing will carry to abnormal levels, just as we regard it unsafe to assume, in the early stages of a downswing, that the movement will carry to subnormal levels. We hold that the conditions of every major business swing are different, and that it is these constantly altering conditions, rather than theoretical expectancies, which should be given the greatest consideration."

Doubtless, these views have been reinforced by the fact that Standard has found "no combinations of data or of graphic curves which will inevitably foreshadow what is going to happen." The Standard system of forecasting has, therefore, "not a basis, but several score of bases; under different conditions the bases radically change. The important thing that we have learned about business forecasting is that the most dangerous tool imaginable is a fixed system, or inflexible ideas as to what are correct and incorrect methods.

In May, 1923, when business activity showed signs of weakening, the Service arrayed on one side the casual forces which it held responsible for the lull, and, on the other, the fundamental elements of strength in the situation, and decided that the business recession would be mild and temporary. I will not take time to enumerate the list of factors they take into consideration.

Now, in summary, what can a person do for himself? I think much can be said to the man engaged in general business who doesn't want to subscribe to all services and doesn't want to incur the cost of setting up his own organization.

First, no service has any sort of monopoly of a valuable method. There are no secret sources of economic data and no secret formulae of any importance. There are some details but a study of their actual forecasting over a term of years shows that none of their trade secrets would make any great difference.

The second point is that no elaborate technical preparation as a forecaster is necessary. All that is known that is especially forecasting technique could be put in 1,000 pages. The principal things necessary are (1) some knowledge of history of business cycles here and in Europe and (2) knowledge of what these series mean, for instance, the employment index of the Bureau of Labor Statistics. I use that because it is so grievously misinterpreted.

Concerning the analysis of special non-cyclical conditions, it is impossible to make general statements which will be of much value. The forecaster must evaluate such diverse factors as the prospects of war and peace; the activity of political propagandists; the accumulated shortage or surplus of buildings, of railway facilities, and of ships; the course of international payments; and the probable trend of prices. In each case as it arises some of the factors are entirely new to the forecaster's experience, and in regard to others, he lacks accurate data for his conclusions. He must bring to bear on the problem the whole range of his economic education; special instruction in forecasting avails him little.

Finally, there is a question of theory. I am very fortunate that my time has run out before I take up that because the best I could do would be to indicate a number of theories I don't agree with. I am not prepared to furnish the key to an explanation of the causes of the business cycle, although that is what we need to unlock the future. Once we have that, we can cut loose from all this empirical sequence but as long as we don't, I think we are necessarily thrown back on the compromise, using such knowledge of cause and effect as we have, and supplementing by observation of the sequences. (Applause.)

Chairman Bell: I think we will give all the students in the room who find it necessary to go to their classes at the present time an opportunity to move along and as soon as quiet is restored in the shifting of classes, we will ask Dr. Hardy to resume for a few minutes and discuss the causes of the business cycle.

Dr. Hardy: Since Mr. Bell asked me to, I will read the first paragraph of what I had intended to say.

"It would be very desirable at this point, before summarizing our conclusions as to the best method of forecasting, to present a statement of the causes of business cycles which would serve as a basis for rational forecasting by the method of economic analysis. As we have indicated, we do not believe that forecasting can ever become an exact science until we get beyond empirical deductions from the sequence of past phenomena and ground our analysis in a study of the effects which may be expected to flow from causes which we observe at work. An adequate cycle theory should be of great value for this purpose. Unfortunately, we cannot offer such a theory.

"We have an hypothesis which seems to us more satisfactory than the alternative hypotheses that have come to our attention, but we are convinced that economic research has not yet given us such an adequate and convincing theory of the cycle that one can afford to put reliance in it for forecasting purposes, without making use at the same time of the method of historical sequence. Most of what we have to say on this subject is, therefore, of a negative character, and I will just deal with a few of the 200 theories that have been developed. It would be taking un unfair advantage of Mr. Bell to attempt to cover them all."

One of the most widely accepted cycle theories finds the cause of business depression in a shrinkage of profit margins at the top of the cycle. These, however, whatever may be its merits from the standpoint of logical analysis, cannot be verified statistically, nor made of much practical use for forecasting purposes, because of the scantiness and tardiness of our information concerning profits. Outside of the railroad field, too few corporations publish adequate information frequent enough and prompt enough so we really wouldn't get anywhere, even if we could accept that theory without qualification.

I insist on passing over the theory that the prime factor controlling business activity is the rate of interest since it is the subject of the succeeding paper on this program. Irving Fisher has recently brought out a theory of the cumulative effect of prices on business which rests on a new statistical technique. It is very interesting and it may very well be he has found a key to unlock the secret. I have a feeling, however, that that is by no means proved yet and will take a great deal of work and proof for this reason: what he has done is he has taken the hypothesis that prices control business activity and tested that by a peculiar statistical technique that gives him high correlations between prices and index activity. It seems that is not enough. What you have to do is apply the same technique to other hypotheses. We may find a number of other things which, when manipulated, would show equally high correlation and be equally well approved.

I shall not pause either to discuss the effect of political conditions on business activity, except to say that I believe that current financial literature invariably greatly exaggerates the importance of every political issue. It is very rarely that the outcome of an election makes a tremendous difference. Of course, a change in tariff may make some difference to an individual community, and a change of taxes makes a lot of difference to individuals but most of the effects of political changes are matters of shifting around the burden of government. While it is almost impossible to make a general statement, I think the economic importance of political issues is very much exaggerated. People who sell out interests in industry on the strength of a political scare nearly always make profits for the other fellow by so doing.

In my own judgment the most hopeful attack on the problem is along the lines of the theory that the business cycle is an alternation of over-production and under-production, caused by the fact that production is controlled by inadequate information concerning the total volume of consumption, and more important, by inadequate information as to what rival producers and speculators are doing.

Let us assume that at a given time there is evidence of demand in a given line sufficient to justify an increase in the rate of production. The first managers who adapt their plans to this situation are probably rewarded by increased profits. Under competition, however, the tendency is for an increasing number of persons to try to take advantage of the situation, each more or less in ignorance of the other's plans, and no force intervenes to check the continued increase of production till it reflects itself in declining orders, and falling prices. By that time, however, investments have been made, contracts let, and operations started which will result in further augmentation of the supply. Time is required to check this increase in the volume of production, and during this time production outruns consumption unless consumption is stimulated by unprofitably low prices. Moreover, just as was the case on the upswing, the indications that production is being overdone result in curtailment of operations by independent producers in ignorance of each other's intentions, and this tendency continues till output is decreased to a rate below that which is economically justified.

My favorite illustration of that is a thermostat. If you ever tried to heat a house with hot water and hold the heat at 70 degrees, you know what I mean. By the time you get the house up to 70, there is enough heat in the water to bring the house up to 72, with the fire checked. And then, on the down-swing, you have the same thing—you get a cycle of overheat and underheat. If you have a hot-air furnace, the adjustment comes through more quickly. And, the system of controlling production through prices and advance orders is comparable to the hot water rather than the hot air. (Laughter.) I don't use hot air in any figurative sense.

A second cause of the cycle, very similar to the first but quite independent of it, is the effect of uncertainty on the decisions of speculative buyers with regard to the accumulation and decrease of stocks. Throughout the industrial order, a large part of the transferable wealth, including raw materials, half-finished products, and goods ready for consumption, is in the hands of individuals who can, to a greater or less extent, adjust the size of their holdings to changing conditions, and who do, as a matter of fact, adjust them chiefly in accordance with their judgment of the probable course of prices.

This would be of no consequence, so far as the cyclical tendency is concerned, if all these judgments of the trend of price were formed independently, for some would overbuy when others were underbuying. The net result would be a fairly steady rate of buying if the number of buyers was large, or an unpredictable irregularity if the number was small. But, the judgments are not formed independently. They are all formed, in large part, on the basis of the same evidence, and of that evidence, the most influential part is the trend of prices in the recent past. Whatever prices have been doing is accepted by a great many as the most likely thing for them to continue to do, so that the higher they go, the more the tendency to speculative buying, and the lower they go, the more the tendency to use up stocks and buy from hand to mouth.

Most of you are familiar with the Hoover program. The great increase in the range of statistics is in part an outgrowth of Mr. Hoover's conviction that the increase of information along this line was one way of flattening out the business cycle. I presume the great increase of statistical data from the Federal Reserve Board is to be explained by the same theory. This is a guess on my part but I have a hunch that the moderate character of the swing of business over the last four or five years has been, in a large part, an evidence of the success of this program of spreading information so it shall not be possible for over-production or under-production to run as far as it would if everybody had a larger degree of ignorance of the other man's plan. My own judgment is that at present the statistical activities of the Federal Reserve Board are more influential and have greater possibilities of usefulness than the responsibility the people are trying to put on them of the manipulation of interest rates, and that the relative steadiness of business in the past three years is the result of concerted activity of that sort.

THE USE OF INTEREST RATES AND PRICES IN FORECASTING BUSINESS

By

B. B. Smith, Chief Statistician for the White Motor Company,
Cleveland, Ohio.

(Thursday Morning, October 28, 1926.)

Chairman Bell: Our next speaker is at present statistician for the White Motor Company of Cleveland. He has done statistical work for the Government and has written on statistical data in connection with the interpretation of fluctuations in business. He will supply us with some information with regard to forecasting business and give Professor Hardy something additional to put in his book that comes out on January first. Mr. Smith.

Mr. Bradford Bixby Smith: The subject I am going to speak about is "The Use of Interest Rates and Prices in Forecasting Business." After Mr. Hardy's able description, the first two or three paragraphs may be a repetition.

The subject of the relationship between interest rates, prices, and general business is not new. Interest rates and prices are matters intimately connected with the functioning of the business cycle and as such have received the attention of many students in economics. The objective study of business cycles in this country was given its first important stimulus by Professor Wesley C. Mitchell's classic on the subject. But, at that time there were comparatively few statistics and but undeveloped statistical methods with which to test and apply the theory of cycles. Somewhat later Professor Persons under the auspices of the Harvard Committee on Economic Research was able to give the theory of business cycles a more rigorous statistical test. In general, his methods were to construct statistical measures of the desired phenomena such as index numbers of "general business," speculative activity, and commodity prices. From these measurements secular trend and seasonal variation were customarily extracted and the residual variations were graphed in terms of standard deviations, under the name of "cycle." Cycles were then compared for similarity or lag of movement, from which deductions as to sequences, relationships, and future tendencies were drawn.

In all of this, the inter-relationship of interest rates, prices, and business activity played a general part, although they were not the prime focus of attention. Recently, however, more specific studies have been made of these items such as Carl Snyder's illuminating study recently published in the "American Economic Review." These studies have shown an increasing tendency to lean on statistical demonstrations.

But, in practically none of these studies do we find any precise delineation of the relationships, such as the regression curve. For the most part, the statistical technique is descriptive rather than analytical in nature, consisting primarily of time series graphs toward the movements in which a discussion is directed. Thus, such generalizations as "when interest rates rise such-and-such an amount, stock prices do such-and-such" or "several months after commodity prices turn down, bank clearings fall off" are the typical product of such analyses. That there are relationships, practically no one denies. From a qualitative point of view, they are admitted but with regard to their quantitative delineation practically nothing has appeared. There has been too little employment of dot charts, regression coefficients, regression curves, correlation surfaces, and the like, which are the chief tools for establishing statistical relationships. Furthermore, the statistical analysis, such as there has been, has for the most part been limited to studying the movements of two factors, and two factors only, although many factors are at work. Thus, the relationship between interest rates and security prices is a favorite subject, or the relation between price changes and general business. True, other factors are brought into the discussion as explanatory of why supposed relationships failed to function at certain times, but though brought into the discussion, the statistical analysis fails to comprehend them, and until it does, our quantitative basis for forecasting is inadequate.

To describe statistically in a thorough manner the working of several economic forces in bringinig about a given condition in business, it is essential that the relationships of these several factors to business be given *simultaneous* treatment. It is impossible, for example, to find a consistent, continuous relationship between changes in prices and changes in business activity a year later unless interest rates are considered. For, in several instances it may be possible to demonstrate beautifully that when prices rise a certain per cent, business will show a certain specific stimulation.

But, in other cases, with the same percentage rise in prices, business may prove to have declined, simply because some other factor, such as financial stringency or high interest rates, has exerted a depressing influence. In this way, the operation of the interest rates obscures the relationship between price changes and business. The only way to find the true relationship is to consider the movements in business as the resultant of several forces and to discover the relationship of business to those several forces can be accomplished, up to the present time, only by multiple correlation procedure or its equivalent.

The study of the relationships between business conditions in a given year and economic forces during preceding years which I am now going to describe is preliminary in its scope and represents an application of these methods to a generally recognized theory of relationships. If the relationships between certain measurable economic phenomena and business conditions a year later can be given a quantitative expression, it is, of course, an almost mechanical affair to forecast business conditions a year in advance with an accuracy dependent only upon the constancy of the relationships discovered. Although this study is but in its initial stages, the first results were sufficiently encouraging to justify its presentation at this time.

The general theory of economic relationships which served as the basis for the statistical analysis is briefly summarized as follows:

One of the most basic things affecting business prosperity is the movement of the price level. Thus, when prices are rising, the mere holding of goods on the part of enterprises is profitable, for the value of the goods enhances with the passage of time. When prices are once started on the upswing, the movement tends to augment itself for business enterprises hasten to make purchases before the prices go higher and at the same time fail to make commensurate effort to dispose of the goods on hand, even going so far as to withhold these goods from the market pending higher prices.

The obvious ultimate result of this process is to tie up the financial resources of the country in stocks of goods at points in the distributive channels where these goods cannot satisfy the needs and wants of consumers. Furthermore, since the rise in prices is not paralleled by a commensurate increase in wages, the actual

quantity of goods reaching consumers tends to be reduced. A much greater proportion of the country's stored-up savings, financial resources, than usual is tied up in the production-distribution process, and is not doing the job as well. It is inevitable that, sooner, or later, further expansion of the financial structure will be impossible. As this time approaches, higher and higher prices are paid for the loans necessary to carry the increased stocks, as evidenced by the increases in interest rates; bank loans are expanded and the ratios of reserves to liabilities indicate financial stringency.

The increasing financial stringency overtakes the increasing prices, and a crisis is at hand. For, when the surplus stocks can no longer be carried, there is but one recourse and that is to sell them. They cannot be sold unless their price is definitely reduced. The rapidly falling prices resulting cause failures and forced liquidations, for each company's losses prevent its paying its creditors. The process of deflation continues until surplus stocks are worked down and financial resources built up whereupon production can again be recommenced.

With this general theory in mind, the first step in discovering the quantitative or statistical relationships among the various factors is to construct statistical measurements of these factors which will reflect the concepts required by the theory. Thus, the first factor was "rising prices," or "rate of change" in prices. Whatever series is used to represent this factor must be such that it measures the increase or decrease in prices rather than the level of prices. As Professor Fisher has pointed out, it is the change in prices rather than the level of prices which influences prices. It is well recognized, for example, that men can do business at any price level but that changing prices require much adjustment. A customary method of measuring changes in a series is to use "first differences." But, since prices as measured by the Bureau of Labor Index of All Commodities have ranged from 80 to 250 or so in the past 25 years, it is desirable to express these differences in terms of percentage rather than absolute change. For, a change of five points in a price level of 80 is much more significant than a change of five points at a level of 250. This follows the procedure of Professor Fisher, who has used a measure of "rate of price change" with considerable success in studying the relationship between prices and concurrent physical production. His success in this investigation leads to the adoption of his measurement for "rate of price change" in the price level. Briefly, the rate of price change for any given month is defined as the difference between the index in the following month and the index in the preceding month expressed as a percentage of the index for the given month. The measure will be positive when prices are rising and falling.

But, the effect of a price change in one month on business is necessarily merged with the effect of price changes in the preceding months. Thus, if prices rise sharply for a few months, it tends to stimulate business, but if in the next few months they fall again, the effect of the rising prices is often offset. For that reason, it is desirable to average together the rates of change in prices for several months to secure a measure to which it is possible to ascribe changes in the volume of business at a later date. The choice of the length of period over which these rates of change should be averaged is one which must be somewhat arbitrary unless one is in position to undertake exhaustive experimentation. The period selected was 24 months, a period which Fisher found successful in explaining the relation between price changes and current volume of business. A further consideration is also important: probably by the time two years have elapsed, any price changes which have taken place will have been so completely evaluated that they will have but little further effect on business. On the other hand, the more recent price changes probably exert a much greater force upon business. Hence, in averaging the rates of price change over the preceding 24 months, these rates of change should be given diminishing weights in receding order. This was accordingly done, the more recent month being weighted eight times as much as the earliest month. In this manner a moving weighted average percentage price change series was computed. The figure for any given month represents the weighted average percentage rate of price change over the preceding 24 months.

Just as the theory of business relationships which serves as a basis for this analysis called for a series which would measure the effective rate of change in commodity prices, it also calls for a series measuring the effective rate of change in interest rates. For, although interest rates may be low, sharp increases are apt to have a deterring effect on business. Conversely, a decline in a high rate of interest is important even though the rate yet remains high. Therefore, in a manner analogous to that employed in measuring price changes, a series was constructed for short time interest rate changes so that the value for any given month represented the weighted average rate of change in interest rates over the preceding two years.

But, with interest rates, it is not only important to measure the rate of change, but it is also important to measure the level of interest rates. For, high interest rates are one of the best indications of financial strain and as such, have an important bearing on further business developments. But, interest rates are only high relative to a normal. This normal changes with currency inflation and other factors as pointed out by Fisher and Snyder, and may be considered as the yield on high grade long term bonds as pointed out by Ayres. Hence, the monthly short term interest rates were expressed as percentages of bond yields for the same month, which gives the third series used in the analysis.

The fourth series used in the analysis was the average volume of business during the preceding 12 months as measured by the average percentage of total blast furnaces in blast. If business has been at a low level, the natural reaction is towards higher levels. On the other hand, if business is already at high levels, it requires considerable stimulation to raise it to yet higher levels; the natural reaction is towards a lower level. Hence, it is obviously important to include some measure of what business volume is at the given time when attempting to forecast what business volume will be in the future.

The fifth series used in the analysis was a series to represent the passage of time, or trend. For, it is possible that as the business of the country becomes gradually better and better organized, the same set of economic circumstances may have a gradually changing effect upon the changed course of business. In some cases, the change is somewhat sudden. It was found, for example, that the introduction of the Federal Reserve System marked a definite change in the effect of the several influences considered.

The measure of business to which these series just described were related was the average percentage of furnaces in blast during the ensuing 12 months. The original percentage figures are taken from the Iron Trade Review. This index was chosen because it happens to be the business indicator which coincides most closely with the fluctuations of the business of the company with which I am connected. It is, however, very similar in its contours to the

Tel. and Tel. Index of General Business, to the Standard Statistics Corporation's Index of Industrial Activity, and to the Harvard Index of Manufacture.

Now that the various factors included in the theory to be tested have been given statistical expression, the next step in the analysis is to discover just what are the relationships between the five independent factors and the dependent. More specifically the relationship of the average percentage of furnaces in blast for the 12 months following the given date to the following five factors is to be discovered: (1) Trend or (t); (2) average rate of price change during the two years preceding the given date or (p); (3) average rate of change in interest rates during the two years preceding the given date or (j); (4) the percentage that short term interest rates are of bond yields for the month preceding the given date or (i); (5) the average percentage of furnaces in blast for the 12 months preceding the given date or (b).

This process is almost entirely mechanical in nature and consists merely in finding the functions in the following equation by methods of curvilinear multiple correlation.

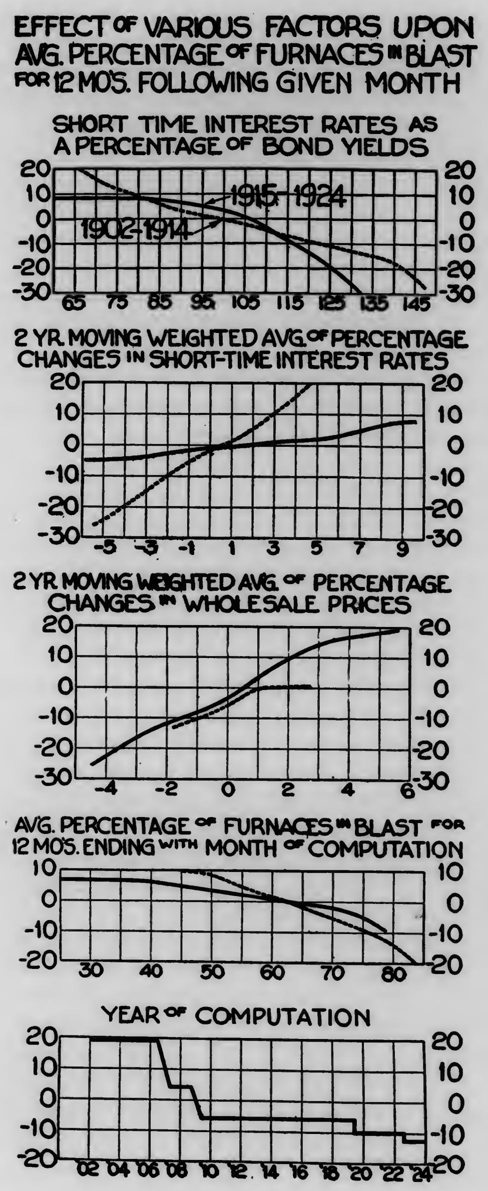
$$X = F_1(i) + F_2(j) + F_3(p) + F_4(b) + F_5(t) + K.$$

where K is the constant of the equation.

The method of analysis followed standard procedure with one modification: the introduction of the Federal Reserve System marked a rather definite change in the relationships discovered. Hence, it was found desirable to carry out a "double" analysis—the first part for the period 1902 to 1914, the second for the period 1915 to date.

Since the functional relationships discovered were found by methods of repeated simultaneous approximation, it is convenient to show them as curves on coordinate graphs rather than to attempt to give them a mathematical definition in formulae. In these graphs there are two curves for each factor. The broken curve represents the relationship prior to 1915 and the solid curve the relation subsequently. The ordinates, or vertical measurements on the graphs represent the effect of the given factor upon the average percentage of furnaces in blast during the following 12 months. The given factor is measured along the abscissae, or horizontal direction.

The first of the graphs has to do with the relationship between short term interest rates as a percentage of bond yields and the



average percentage of furnaces in blast during the following 12 months.

It is interesting to note the difference between the two curves for the two periods. Before the Federal Reserve System, if interest rates fell below 80 per cent of bond yields, they continue to stimulate activity in the following year.

Thus, if interest rates were 80 per cent of bond yields, the effect on the blast furnace percentages in the following year was plus 10 per cent, whereas if the interest rates fell to 65 per cent of bond yields, the effect became plus 20 per cent. Since 1914, however, interest rates lower than about 80 per cent of bond yields seem to have no more stimulative effect than the interest rates at 80 per cent. This may mean that business is so organized that it can take full advantage of falling interest rates as they decline without having to wait until they reach exceedingly low levels. I offer that merely as a suggestive explanation.

At the other end of the curves, it is apparent that nowadays it does not require as high interest rates as formerly to bring about a given depressive result. Thus, an interest rate 130 per cent of bond yields has today an effect on future business conditions about equivalent to an interest rate 145 per cent of bond yields in pre-Reserve System days. This curve comes down much more sharply so the interest rate doesn't have to go so far across before the reading on the scale comes down to the low point.

If interest rates in New York are today more truly representative of interest rates throughout the country than they were before the Federal Reserve System, which is likely, this, then, would explain the difference between the effect of rates as measured in New York today and their effect formerly. In short, the per cent that interest rates are of bond yields in New York in these times does not have to be as high as formerly to indicate a strained condition throughout the country as a whole, owing to the freer flow of finances made possible by the Reserve System.

The next graph has to do with the relationship between the average rate of change in interest rates and blast furnace activity in the following 12 months. The first rather surprising thing is that the greater the average increase in the rate of interest, the greater the average percentage of furnaces in blast in the following 12 months. This is somewhat surprising in view of other findings wherein it has been concluded that increases in interest rates herald business declines. The findings of this study might have been similar if the measure of the level of interest rates already discussed were not also included. But, if the two measurements are considered together, the relationship appears logical. Take interest rates, for example, at a low level. The first graph shows that the effect on business is stimulative. As business begins to expand prices rise as does also the price of money, the interest rate. This process continues for a certain time and hence rising interest rates as well as rising prices come to be indicative of business prosperity rather than business depression. Increasing interest rates are a manifestation of the fuller employment of capital. But, observe that when the rise in interest rates carries those interest rates to high levels, the interest rate influence is a depressive one as shown in the first graph. Or, if business itself, instead of the interest rate, is carried to high levels, these high levels in themselves are a depressive influence as will be discussed in connection with a subsequent graph. One other feature is pronounced in the graph representing the effect of changes in the rate of interest: before the war a given change in the rate of change in interest rates had much greater effect than it does now, for, as may be observed, the curve representing the relationship before the war has a much steeper slope than the curve representing the relationship since that time.

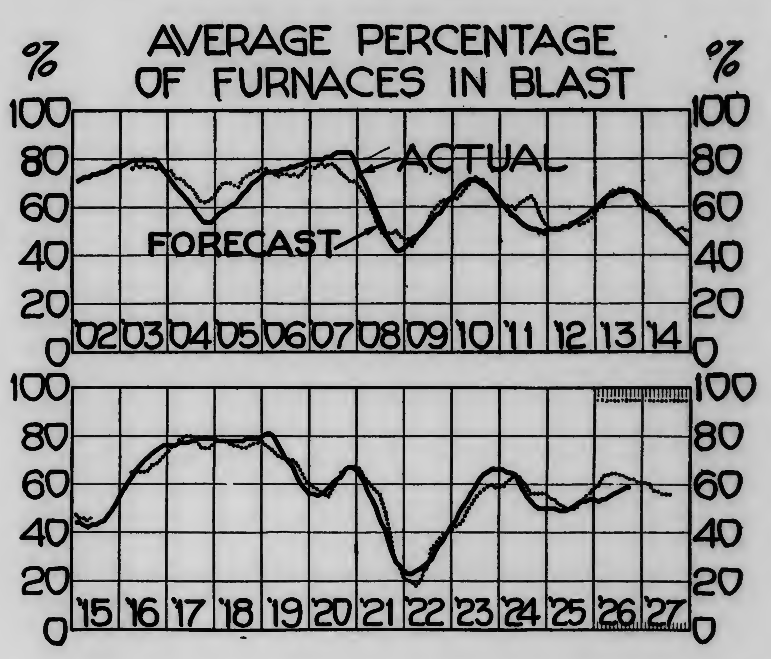
Observing the graph representing the relationship between the rate of change in commodity prices and subsequent business conditions, it will be noted that this curve proves to be what would be expected: increases in the price level have a tendency to stimulate business whereas declines have the opposite effect. The merit of the curves in this graph is that they tell us how much effect any given average rate of price change, as defined, will have.

The graph representing the relationship between the average percentage of furnaces in blast for the twelve months preceding the given date and the average percentage for the twelve months following the given date is also as theoretical considerations would indicate. High levels of activity are the natural forerunners of lower levels and vice versa.

The last graph represents the trend correction applied during the years included in the analysis. The chief item of note about this curve is the sharp drop between 1906 and 1910. The reasons for this correction are probably two: in the first place, there has been a gradual increase in the efficiency with which industry is carried on and as a result, a fewer number of furnaces out of the total are capable of supplying the country's needs, those which are the more efficient. This would account for a downward trend which would partly explain the sharp drop from 1906 to 1910. But, there is a second reason for the particular drop during that period which I believe is inherent in the method of computing the percentage of furnaces in blast. Although there is not much error in the first figure, the second figure may be susceptible to considerable error according to the point of view held. The point of view held here is economic, rather than physical. Thus, after the sharp decline in business in 1907, a good many furnaces blew out, and although from a physical point of view a considerable number of idle furnaces in the immediate years following could have been blown in, from an economic point of view they were dead forever —they were too inefficient to compete again. Larger and better furnaces took over their work. This is witnessed by the fact that the recovery in pig iron production was much greater than the recovery in the blast furnace percentage. In short, the total number of furnaces available, which constitutes one-half of the fraction from which the percentage of furnaces in blast is derived, was not reduced rapidly enough for the purposes required here. Hence it was necessary to supply a correction, as shown in the curve entitled "Year of computation."

From the economist's and statistician's point of view, the relationships which have just been discussed are the most significant part of this study. But, from the business point of view, the application of these relationships to forecasting is of greater interest. If the relationships discovered are as true in the future as they have been in the past they can be employed to forecast the future with an accuracy limited only by the accuracy of those relationships. The method of using these relationships for that purpose is very simple. The value of each of the factors discussed is first secured for the given date and then, by reading from the curves, the effect of these several factors on business during the next 12 months is obtained. These effects are added together and the constant, 65.7, of the estimating equation added, and the forecast is complete.

The next logical step is to suppose that we were back in 1902 and wished to use these relationships to forecast 1903 and, therefore, computed the estimate as suggested. If this estimate were computed each month since that time and plotted on a graph as the forecast of the next 12 months, it would look like the forecast curve in the accompanying chart. The test of the accuracy of the relationships lies in a comparison of this estimating or forecast curve with the actual result as it turned out to be. For the sake of this comparison, the curve of the actual percentage of furnaces in blast is also shown on the chart. In this graph any point on a curve represents the average percentage of furnaces in blast for the 12 months ending with the indicated month, one curve the forecast, the other the actual. Note that the forecasting curve indicates faithfully the depression of 1908, the fluctuations that took place during the World War, the severe depression immediately following the war, and the subsequent fluctuations. A period offering a more rigorous test of such relations could hardly be found. The



correlation between the two curves is about .94, and will be recognized by students of correlation technique as the multiple correlation index.

In closing, I wish to call attention to some of the limitations of forecasts based on this type of analysis. There are several, both from the point of view of statistical technique and also from the point of view of economic evolution.

From the point of view of statistical procedure there are two chief sources of error. In the first place, the particular measurements set up of the various factors, such as the series representing the average weighted rate of change in prices, may not be the best possible measurements of the given factors. Perhaps some other index than the Bureau of Labor All Commodity Prices would have been better, or perhaps some special index of a selected group of products. An index of general rather than commodity prices might have been more appropriate. Furthermore, there is no surety that the manner of measuring the rate of change and of averaging these rates of change was the best. And, even if this were the case, the suitability of such measures and methods may be changing systematically, perhaps even suddenly, as we move forward through time. Hence there is this source of error always to be reckoned with in using such an analysis for forecasting purposes. The second statistical limitation of this type of analysis is that the relations found were found only after making a certain assumption necessarily inherent in the mathematics of determining the relationships, namely, that the functional contribution of each factor to the variation in business was independent of the values of other factors. This is not necessarily the case. In fact, joint relationships are easily conceivable. Thus, the effect of a high interest rate may be greater when business is at high levels than when it is at low. Methods of solving for joint relationships, however, are yet in their infancy. This constitutes a second limitation, from a statistical point of view, in using the analysis.

From the economic point of view there are also two considerations which would tend to invalidate the use of this analysis for forecasting. In the first place, the factors which the theory of business reactions indicated were to be employed in the analysis may be the wrong factors, or they may be factors whose importance may be dwarfed by the entrance of new factors into the situation. Unquestionably the factors selected and measured are not the ultimate factors. Thus, the interest rate in itself and by itself is not so much of a factor; it is rather the condition of the supply and demand for capital which is indexed by the interest rate that is the important factor. And, back of these are the growth of the population, the success of crops, the adjustment of human enterprise to human needs. Each of the factors selected and measured may thus be considered as symbolic of significant fact rather than significant fact itself. If they should fail to reflect the facts, or come to represent different facts, then the validity of this analysis for forecasting is diminished.

The second economic consideration tending to invalidate the use of this type of analysis for forecasting is that in human affairs all things change. The relationships discovered may change. One such change has already been observed when the Federal Reserve System was introduced. Future changes may also be expected. This is perhaps the most fundamental weakness in all statistical forecasting. On the other hand, it is a weakness which is shared by all forecasting, whether it be statistical or non-statistical in nature. For the only basis of forecasting the future is past experience, and if past experience fails to be indicative of future experience not only the purely statistical but all other scientific forecasting is deprived of its very foundation. (Applause)

RECENT ADVANCES IN ECONOMIC SCIENCE IN THE STUDY OF PRICE TRENDS

By

Carl Snyder, Federal Reserve Bank of New York
Dr. E. O. Merchant, Presiding

(THURSDAY EVENING, OCTOBER 28)

Dinner Meeting—Faculty Club

Chairman: We now come to the final address of the day. The speaker needs no introduction to you. You recall that a certain pickle manufacturer made himself famous with Fifty-Seven Varieties, and the speaker this evening has made himself famous by originating an index of the volume of trade, containing 56 varieties of statistical series—he is one short.

During the course of the day we have stirred up a little disagreement as to whether commodity prices were going up or down, and we have also had a little disagreement as to whether the mathematician or the economist was the proper party to engage in statistical analysis. The speaker has not told me just what he is going to talk about. He may disregard the latter controversy but I am pretty sure he is going to have something to say that may settle our ideas as to the trend of commodity prices before he gets through. I take pleasure in introducing Mr. Carl Snyder, Chief Statistician of the Federal Reserve Bank of New York.

Mr. Snyder: Mr. Chairman, gentlemen: I brought with me a very nicely written manuscript which I am very loathe to abandon because some of it I thought was very beautiful, but after listening to the erudite and highly technical discussions of the day I felt that it was perhaps far too literary and possibly elementary. I think I can get through more rapidly and give you the gist of what I wanted to say and abandon the precious document.

I don't need to remind you that the relations of money or credit and prices and other influences upon trade, and the so-called business cycle, has been a battleground, you might say, of the economists and statisticians and of the mathematicians for more than a century, ever since the Napoleonic wars, in fact. It is a singular thing that some faint beginnings of statistical proof might have

been possible in the day of Ricardo and Malthus. But Ricardo expressly rejected the idea that you could measure anything as a price level, and Malthus and John Stuart Mill, and the rest of the classical economists seemed almost of the same view. It was the service of William Stanley Jevons, about 1860, to inaugurate the idea of a definite measure of average prices and the reciprocal value of money. But even that did not seem to open the way to any statistical investigation of the extremely important relationship of which I speak.

It was left not to an economist but to a mathematician and astronomer, Simon Newcomb, to put together the theory in mathematical form, which he did just 40 years ago. I believe that independently Prof. Nicholson did practically the same in England. Newcomb's idea was essentially that of taking over into the field of economics the conceptions of dynamics or mechanics—rather dynamics. That is, that the price level must be a ratio between what I may call the volume of trade, production, exchange of all kinds, and the units or media used in these exchanges. He introduced the conception of a velocity.

The old quantity theory assumed that this rate of turnover of the circulating medium or money was practically negligible. Newcomb said that it was equally a factor and must be taken into account, and so he devised a formula, the familiar one which you know in the works of Fisher, and others, that the amount of money in circulation multiplied by the speed or velocity of circulation and divided by the volume of trade, must give you your price level.

$$\frac{\text{M (money)} \times \text{V (rate of turnover)}}{\text{T (volume of trade)}} = \text{P (general price level)}$$

Now, it was left for a young graduate student at Cornell University, Dr. Kemmerer, to attempt the first statistical demonstration or make the first statistical investigation of that formula, which he did just 20 years ago. In a far more elaborate and detailed way, Prof. Fisher followed some five or six years later, with his "Purchasing Power of Money." Both of them tried to measure the annual rate of turnover of money, and of deposits, to get from that some rough concordance with a price level. Both agreed in rejecting the idea that commodity prices at wholesale were alone sufficient to measure the general price level, as Jevons and others had assumed. They tried to make a general index of all prices or of several kinds of prices, but the data were scarce. Also, there were practically at that time no monthly data available. The war brought us, in one way or another, an immense recruiting of new material and so it occurred to me when the opportunity came, that it might be possible to utilize this new material for more definite measurements.

The first problem that presented itself was a measurement of the element of trade. How measure the vast volume of exchanges which today for this country reaches above seven hundred billions a year? The total amount of bank checks drawn on all the banks of the country now exceeds six hundred billions of dollars. According to the assumptions that have been made on the basis of Kinley's work, cash transactions would add something like a seventh more. We had various quantity data but they did not completely fill the bill because so largely they related to basic production. From these had come what I have been inclined to call the "pig iron complex," that is, the idea that pig iron and its congeners, very violent and bad actors at times, were an accurate measure of general trade. I think everyone felt that it was highly desirable to get something better, but it was extremely difficult.

Prof. Fisher and Dr. Kemmerer both tried such things as postal receipts and some others, but it wasn't until it was possible to get a great variety of data and some data at least as to wholesale and retail trade and that like, that such a measurement seemed feasible. So we put together practically every index that was available from the beginning of 1919, by months, 56 different series, and put those together according to the best weighting that we could devise into an index for the last seven years.

Now, as to the question of a base. Volume of trade or production in 1913 or 1813 has something of the same historic interest as the price of wheat in the days of Queen Anne, but not much more. Every year the trade of the country grows, and grows at such a remarkable rate that very rapidly any base year is out of date. My favorite illustration is the growth of railway traffic. We figured out that in 1852 (that was as far back as we could get any figures) the railroads were carrying something like a billion ton miles all told. It was a marvelous achievement for that day and was so considered. Today when the railroads are carrying upwards of 400 billions of ton miles, nobody thinks anything about it; hardly anyone knows anything about it—we take it as a matter of course. This great sweep of development of railway traffic is

parallel to but no doubt much in excess of the growth of the real volume of the trade of the country. At any rate, what we do know very definitely is that trade, aside from the mere growth of population and its needs, has had an intense development in this country, probably greater by far than in any other country in the world, that is, per capita.

For example, in George Washington's day the average haul of goods couldn't have been more than four or five miles from the place of origin. They had hardly any good roads, and such traffic or trade as went on was largely in ships. The Erie Canal and other canals brought a great development, and then came the railroads, and now we have the further development of the automobile, all of which has meant a steady augmentation of the per capita volume of trade.

So what possible base of measurement have we except to take this growth itself as our base, as our norm or normal that Prof. Morris was talking about today? That is to say, just as we can compute the growth of population so you can compute in the same way the growth of trade. At least we can compute the growth of basic production for 50 years, and have done so, and we know substantially that it has grown at something like 3½ per cent per annum, perhaps just a shade less in the last ten years.

The growth of trade must have been more or less parallel to that, or somewhat in excess of it. What we tried to do was to get some estimate of what in physical terms this volume of trade was, and how each year stood in percentages of this usual or normal growth. Take as an instance railway traffic. After you have had, say, 50 years of population growth the mathematician has no difficulty in calculating closely what the next 10, 20, or maybe 50 years will show. Such a variety of curves has been worked out that, building up on this basis of expectancy, you can do precisely the same thing with the growth of trade so that for any given year you can say how it compares with what would be the normal or usual rate of growth, projected for a single year. What we have done is simply to take that normal in as many instances as we possibly can and take the variations above and below the line. For example, take railway traffic. Supposing that from a curve of 75 years' duration, the expectation for this year had been a figure of 400 billion ton miles, and that the result should turn out to be 450 billion ton miles. Then your index would be one-eighth above your normal, or taking your normal as a base of 100, the index would be 112½.

Supposing it dropped, as it did, very violently in 1921, to away below any possible expectation, to something like 300 billion ton miles; then your percentage for that year was only about 70 or 75 per cent.

If I make clear the method, it is the idea that we can, if you have data covering a sufficient length of time, compute this normal rate of growth. It is nothing more than a mathematical curve and may be corrected from time to time as it may need correction from the changing trends, if such there be.

Taking that as a base, we can put together each of these percentages into a weighted average, and that is what I have labeled the "Volume of Trade," the heavy black line of the chart. As you will see, the tendency of it has been, save for a single month or two months, to run something like 10 or 15 per cent or less above the normal line, and 10 per cent or so below. In other words, the volume of trade tends to vary from a normal expectancy something like 10 or 15 per cent either way, and probably not more.

Have we any idea as to how far that is an accurate measurement? The objection may be made, of course, that it relates wholly to urban and factory activity, for we have very little measurement of farm activity by months. But I must remind you that less than 30 per cent of our population now lives on our farms, and according to the calculations of the National Bureau, of Professor King and others, the farm income represents less than 20 per cent of the total money income of the country. I think we may fairly assume that the trend of the farm activity will correspond more or less, sometimes less perhaps, to the general state of business of the country, and therefore that we may assume that we have come somewhere near the reality, possibly a little outside of the reality. If I were pressed very closely to say what I thought was the extreme average differences in any given year from this normal trend, that it might be on the order of 5 per cent above and 5 per cent below for the year—not, of course, for individual months.

These variations are what we call the business "cycle," and this is how it looks according to our measurements. Is there any possible way of extending that backwards so that we might get a longer term measurement than the seven years since the close of the war? Before the war the best general index of trade was undoubtedly bank clearings, what we call now bank debits. We had those back 50 years, and they had a very rapid but in general very even trend of growth. If we could make due allowance for the price level, we should then have an extremely good measure of trade through that 50 years. So the question was how to eliminate the violent price changes that have taken place in the last ten years, and to some extent more slowly in previous times, so as to restore bank debits and clearings to a true, accurate volumetric measure of trade.

We were sorely puzzled because if we took our familiar old friend, the Bureau of Labor index of commodity prices, and divided bank debits through by that, we should have business at a higher level in 1921 than in 1920 or 1923. So obviously absurd was this that we set about devising the index of the general price level that I shall set before you tonight.

The result of using such a composite of the various types of prices was to give us a measure of bank debits. That corresponded very closely for these seven years with our index of the volume of trade. That correspondence was so close that we felt that if we could carry back this index of prices, and with it deflate bank clearings—as picturesquely termed "take the wind out"—we could get a measure of trade back for these 50 years. We did and here is the result of the deviations from the trend of growth, which you may imagine rising, if you will, from this corner to the far corner in a steady and steadily decrescent curve. That is to say, it rose much more rapidly in the early period than in the latter period, because of the wider use of checks, the increasing number of clearing houses, the more rapid growth of the country, and so on.

The deviations from this line of growth in 50 years is represented here by the heavy line. You will see (and that is of interest to the students of the business cycle) that the fluctuations of the first half of this period are distinctly larger than in the latter half. In other words, the suggestion is that what we call the business cycle has been damping down, and shortening up, steadily, not for the last 10 or 15 years but for the last 50 years.

Now consider what you have in your volume of bank debits, or bank clearings. You have first your deposits and secondly your rate of turnover, that is, you have a given quantity of deposits which achieve a certain volume or amount of turnover in the course of a month or a year. You have merely to divide the one by the other then, to get at your velocity. What is the result? The interest of this lies in the fact that when we measured first the velocity for the last seven years for which the best data are available, we found that the line was fairly level and the fluctuations relatively small. So the idea immediately occurred to take the deviations from the average, since this average had no secular growth, no element, apparently, of secular change. And taking the deviation from this simple average of the period we get a line which, in a broad sort of way, conforms fairly well with our measures of the volume of trade.

Now there are certain exceptions to that which puzzled us a great deal until we came to investigate it and then we found what you might readily expect; that is, that any sudden increase of bank deposits from any extraneous cause, like gold imports or the like, by which the volume of money or credit in circulation was suddenly or quickly augmented, would automatically reduce the rate of turnover for a given volume of trade. So through certain periods we have a considerable deviation because there was a rapid rise of deposits, and apparently out of proportion to the amount of trade to be done. But as you will see, there was a quick return to about the same proportions, the same levels and the percentages of deviation from this average of seven years are broadly the same as those of the volume of trade. I don't need to suggest to you the bearing of that on our familiar problem.

If it is true that velocity of bank deposits, which are our chief form of circulatory media, vary with the volume of trade or with the deviations of the volume of trade, from its normal, steady, accustomed rate of growth, then this velocity is not usually an influential factor in the makeup of the price level. Therefore, we may say that, substantially speaking, the volume of bank credit in circulation must rise at about the same rate, must increase or expand at about the same rate, as the volume of trade if we are to preserve what you may call a fairly stable price level. If deposits rise more rapidly than trade, you will have an increase of prices eventually and if not, you have the reverse, a fall of prices.

Can this be established? What is the price level? That is the next question. If you take this 700 billions of bank debits and try to imagine where it all comes from you can readily think of a vast variety of different things. You have not merely the turnover of raw materials of which we have an index in wholesale prices, but in manufactures and in the processes of manufacturing, and then to the jobber, if there be such, and then to the retailer before it goes finally to the consumer. You have also the turnover of securities, of land, of all forms of property and you have the payments for wages and professional services of every type. Approximately 40,000,000 people in this country receive a wage or salary. That is to say for professional, domestic, and factory, and all kinds of service, we have a wage, and it is an enormously important element in the exchanges. You have also the element of speculation, which we must consider is a vital part of the real business of the country—a little like the froth on the beer, if you please, that used to be—but nevertheless an important function in itself.

So if we are to measure this price level we must try to get in every kind of prices, and what we did originally was to combine an index of wholesale prices, of the cost of living, of wages, and index of property and money derived from rents, four principal items, weighted by this test, that bank debits deflated or divided by this index should, first of all, prolong the long term trend of growth without change through the war and after the war, in spite of the vast change in the price level. That was the first test.

And secondly, that deviations from that line of growth should correspond closely with (as closely as correlations could make it) our index of the volume of trade for the seven years for which we thought we had pretty definite data. When it was all done we felt that we had a fair approximation.

Subsequent to this, the Bureau of Labor has undertaken to split our familiar commodity price index in two and make the one part an index of farm and food prices, the other of non-agricultural or, as you may say, industrial prices. The present Bureau of Labor index, and most other commodity price indexes, are weighted something like 50 per cent or more, with farm and food products, which is all out of proportion, I think it is clear, to the actual relative importance of those commodities in the final make-up of exchanges. Then we were able to secure a much better composite of wages than we had in the beginning. We now have added farm wages and building wages and railroad wages which we now have by months, so that we have a weighted index of wages of seven broad groups instead of four as before. Next we have recently put through the making of an index, first of security prices, bonds and stocks, weighted; secondly, realty values based upon rents and the cost of new construction.

Putting all these new indexes together, we have made a revision of our general price level that runs a shade lower, but substantially of the same general character. It begins about ten points down and consistently is 10 to 12 points below our earlier composite. The composite is very nearly the same as the index of the cost of living. In other words, you have in our urban cost of living indexes apparently a very close index of what we may term the General Price Level.

Now to sum up: if we take our measures of trade and divide bank clearings or bank debits by them, or if we make independent measures of velocity and of money, which is the same thing practically, we get a ratio that represents the theoretical price level and the question is, how does this derived index compare with the composite I have described? The widest variation is in 1920, at a period when we feel that the indexes of commodity prices were for a time much out of line with reality. That is to say, they had become indexes of current quotations rather than of actual sales. Making that allowance, in those seven years, with the exception of 1920, the deviation is not large. In other words, we have this: We have in demand deposits a fair measure of the circulating medium or medium of exchange of the country. In bank debits, divided by demand deposits, we have a measure of the velocity of deposits of turnover. We now have an approach to a quantitative index of the actual trade of the country and its deviations, and finally we have an index of the general price level as contrasted with any of the special price indexes and making the computation there is no very important difference between the two. That is to say, they come within something like 5 per cent to 7 per cent of each other at practically all times, and for the most part even closer than that. Consider that all of these data, and even commodity prices (which we think are so accurate and over which we have spent such an enormous lot of effort and devised the most perfect and ideal method of dealing with them or averaging them) are simply approximations and cannot be more so; that we can only sample trade to a certain degree of accuracy and can only sample prices to a certain degree, it seems to me that statistically and mathematically the problem of the relation of prices, money and credit, has been substantially and perhaps as accurately as for a long time will be possible, put on a rational basis.

You will want me to say just a word, perhaps, on the question of these price relationships since that is the main interest of the evening. Let us take merely the five years that have ensued since the collapse of 1921. Farm prices had dropped more violently than ever before, and since then have had a swift and steady rise, as you see, up to the end of about August of last year. Substantially speaking, at just a little higher level, general wholesale prices did the same. Non-agricultural or individual prices fell less, had a swift come-back, and then settled down to a pretty steady level. The variation since has been on the order of about 3 or 4 per cent.

The cost of living index, which includes, of course, the retail cost of food, wages paid, rent, and all the other items that go into the family's expenditure, fell less, and has risen less. Substantially the same is true of our composite wage, a pretty steady rise from the beginning of 1922 to the present; that is to say, you see now announcements of wage increases almost every day. The products of factory and mine have been practically stable for more than three years and with very little variation for five years. Farm prices have risen rapidly and have since fallen.

When we have talked about falling commodity prices in the last year we have been talking mainly about falling farm prices and not of general industrial prices. That, it seems to me, is a very important distinction for the simple reason that otherwise it is quite impossible to imagine the actual conditions of the last year. With the steady rise in wages, and at the same time maximum in industrial profits in 1926, even granting all possible increase of efficiency in factory management, it is hard to think of achieving such results on falling prices.

Chairman: I am sure we have some questions we would like to ask Mr. Snyder while he is here. Some of you may not yet be entirely persuaded about this price situation. If you have any questions, now is the time to ask them.

The argument we had this afternoon around the luncheon table was whether commodity prices were really declining or not, and of course if you eliminate the rapid decline which the chart shows on agricultural prices from the indexes that we are used to following, we might decide to revise our ideas somewhat. Professor Morris, are you satisfied with the situation now as regards commodity prices?

Prof. Morris: I would like to ask Mr. Snyder which price index he would use for mercantile prices.

Mr. Snyder: Well, if you use your very sensitive index of ten commodities for your ratio and then want to get something much more stable, the most stable of all, of course, would be this general average or composite. Second to that, it seems to me, would be your non-agricultural or industrial prices. They would answer most, it seems to me, to your factory production such as you are measuring in production, and even to your basic commodities outside of farm prices.

Prof. Morris: You mean the Bureau of Labor's non-agricultural prices.

Mr. Snyder nodded assent.

Question: On what basis did you determine the weights for your general price index?

Mr. Snyder: Dr. Mitchell, Dr. King, and others that we talked to about it, seemed to think that the weighting for wages was out of line, and that we should try to get some other kind of basis. So we went over the various items that enter into possible exchanges —that is, the things that we know—the turnover of commodities, the amount of manufactured goods, the amount of wages paid, estimated, and so on. We have even some rough estimates of the amount of realty values, and very rough estimates of realty transactions, and we have pretty good estimates of the volume of security transactions. I say "pretty good"—they are very crude, of course. But taking them altogether, our new index is almost an empirical rating based on that rather vague and unsatisfactory data.

Then we have now another test, if we take our volume of trade index and divide our debits by that, we get a theoretical price level and the question is then to devise a weighting that should make these agree. The result was, as I said, a fair approximation. I don't know whether by very meticulous measures or by partial correlation we could get an agreement closer yet—possibly so; but I have never been much of a believer in the extreme accuracy of statistical data of any kind, production or prices or trade, or even the measure of demand deposits, because it is an extremely vague figure when you come to get into it. Nor do we even know accurately what these clearings are made up of. Even debits are not an ideally perfect measure, because all debits do not get into the clearings. But I think the evidence is that the residual percentage is very small. So all through you cannot have more than an approximation. I agree it would be wonderful to get the thing down to a hair breadth deviation so that it would all practically synchronize, but I don't feel the nature of the data would justify that.

Question: Have you been able to carry the new formula back to the calculation of the price level for the years before 1913?

Mr. Snyder: Only to 1913. We haven't changed our index of the general price level back of the base year. The data do not permit of further requirements.

Mr. Bell: Shouldn't wages be eliminated from the price level if you are going to use that price level for the purpose of measuring cost of living?

Mr. Snyder: No doubt. But not, I think, from a more general price index.

Take the expansion of bank credit, either in the form of demand deposits or of total loans or investments; in the last four years it has been approximately one-third. Now, the growth of business in that time, measured by any kind of index that you want to think of, of production or basic production or general trade or anything else, can't have been any such amount. The Federal Reserve Board's index of production shows in those four years a very slow relative rate of growth. So that you have this situation, that you have had an increase in bank credit of 33 per cent and of production and trade of 15 or 20 per cent, and that must mean, if the theory is valid, a rising price level and not a falling one.

The only way that I know of to get an empirical index from the data that is available, that will go up and not down, is to include wages, to counteract what I believe is the misleading showing of other price indexes.

Question: Do you include security prices in the general price level?

Mr. Snyder: We have it now, in the new index.

Chairman: What are the probabilities that the fluctuations of business will continue to shorten up as the chart shows they have been doing for the last several years?

Mr. Snyder: That is forecasting.

Chairman: I know it, but aren't there economic reasons why that is taking place, which would enable one to form some judgment as to at least five or ten years ahead?

Mr. Snyder: Looking forward five or ten years, my own notion is that almost inevitably farm prices must resume their pre-war trend. That is to say, land is growing scarcer and labor has been growing dearer, and to have farm prices where they are today is, it seems to me, quite extraordinary. Farm prices at the farm today, in five out of six of the great grain crops, and cotton may be included now—farm prices of all but wheat, in the seven greatest products of the direct yield of the fields are near or below, not merely the 1913 but the 1910-1914 average price level—corn, oats, rye, barley, hay and cotton. With the average of non-agricultural commodities 60 per cent above and your cost of living 70 to 75 per cent, it's a periodical situation.

Question: Doesn't Mitchell's study of gold prices and wages in the period of 1860-1880 show that what you just said was true also following the Civil War?

Mr. Snyder: To a remarkable degree. I don't know about agricultural prices, but it was certainly true of wages. Wages didn't fall anything like so much in the crisis of 1873; after the war they went steadily up, as I recall, the nominal wages at least, up to 1874 or 1875, and stuck there and declined very little, finally coming up slowly together by commodity prices moving up to that level. In other words, you had identically the same spread between commodity prices and cost of living and wages after the Civil War which you now have.

Dr. Bell: Have you an explanation, Mr. Snyder, as to why agricultural prices are falling disproportionately as compared to the price of manufactured products?

Mr. Snyder: My own notion is very simply that it is a pure question of supply and demand, that you can no more stabilize farm prices individually than you can the price of cotton or copper or Cheddar cheese.

I think you would be interested to know what Mr. Henry Wallace, of Iowa, was telling us about conditions in his country. He says there has been a veritable revolution in the last five or ten years in methods of farm production in many ways. He said that particularly in hogs and live stock, they are making a bushel of corn go about 20 to 25 per cent further in the making of meat, partly by reducing the mortality from cholera and partly through feeding tankage and that those of good business heads have done extremely well in feeding both hogs and live stock.

He cited the case of two young chaps, bold and daring, who bought a lot of stock at the right time, and they cleared up about $20,000 last year—good money for farming.

There is no question there has been an increase per worker production in some lines on the farm. They have got in lots more machinery, they are using all these wonderful new devices for seeding and harrowing the big grain crops, and it has meant an increase of farm efficiency.

Chairman: If this declining of agricultural prices is a question of supply and demand, then will it correct itself in due course?

Mr. Snyder: I think so, but I should add that Mr. Wallace thinks the correction will be extremely slow.

Member: If some more farmers should leave the farms, would that correct the overproduction?

Mr. Snyder: Yes, no doubt, but they are very loathe to go, most of them. The farmer pays heavily for his economic independence, his social independence, shall I say?

Chairman: In the meantime, can non-agricultural prices and wages, factory labor be maintained at the present levels?

Mr. Snyder: If we are getting high profits on the basis of present wages and present prices, I don't see why they shouldn't, more or less. Nothing is absolutely stable in the world, you know.

Member: You spoke of the general stability of the long time trend of business. Have you an example of that, and is the rigidity of the standard of living associated with it?

Mr. Snyder: Quite possibly. First of all, your population growth furnishes the basis for a definite increase in your volume of trade. That is A B C. The population grows at, we will say, 1½ to 2 per cent per annum. Your urban population grows at 2 to 3 per cent, and your volume of trade is largely urban trade. So it seems to me that you are accounting there for about three-fourths of the growth, just from the population basis alone, and the rest of it is the increased productivity per worker of all kinds. That rises very slowly, so that you have got this curious situation that the total product, the basic product of the country, that rises pretty steadily and at about the 3½ per cent rate growth, despite the fact the rate of population increase has been steadily decrescent all through this half century.

Member: Can you conceive of sudden changes in standard of living possibly upsetting the trend of increase?

Mr. Snyder: I don't. Probably you have seen Dr. W. R. Ingall's article in the Analist about a month ago, in which he endeavored to show the standard of living had not substantially changed from the pre-war basis. Possibly that is putting it too strongly. But nevertheless, somewhere in between the ideas of Mr. Morris and Mr. Ingall there does lie the reality and the change may not have been so great as we might have imagined.

Member: Speaking of this increase in the volume of trade, what is your opinion as to the influence that the development of the power business, the introduction of electricity, to a much greater extent into all sort of industry, will have?

Mr. Snyder: Unquestionably it means the decentralization of industry to some extent. You can now distribute power anywhere within a range of 200 miles or more from a waterfall. In fact, the rate of growth of power production is only exceeded, as I recall it, by the increase in the manufacture of cigarettes.

Mr. Bell: You still have an annual output of gold no lower than it was before the war, do you not?

Mr. Snyder: Not a great deal lower.

Mr. Bell: Well, unless that changes and your volume of trade continues, won't your reserves become inadequate?

Mr. Snyder: Undoubtedly, if there is no change, but certainly we have enough gold to last us comfortably for at least ten years, if we don't lose a lot of it, and we haven't lost it very rapidly in the last four or five, and who knows what gold production is going to be like in the next ten years?

Mr. Bell: I am interested in that figure on rents. Is there any current index of fluctuation of rents in various urban territories?

Mr. Snyder: For the present period a very good index of that kind is the Department of Labor's, 32 cities reporting, I think.

Chairman: Are there any further questions? No response. If not, we shall adjourn this meeting and ask as many who care to tarry and discuss the subject informally with Mr. Snyder, to do so. I think you will all agree with me that we are greatly indebted, first, to the Committee on Arrangements, consisting of Prof. Bell, Prof. Wills and Prof. Morris, for the splendid program which they arranged for us today; and secondly, to the several speakers who have given us the benefit of their work in the statistical field in the three meetings which we have had. As an expression of our appreciation to Mr. Snyder, I suggest that we give him a rising vote of thanks.

Rising vote of thanks and adjournment.

THE RELATIONSHIP BETWEEN INDUSTRIAL EMPLOYMENT AND DEPARTMENT STORE SALES IN OHIO

By

Ralph J. Watkins, Bureau of Business Research
Ohio State University

(Thursday Afternoon, October 28)

The meeting convened in room 317, Commerce Building, at 2:00 o'clock, Professor Spurgeon Bell, presiding.

Chairman Bell: The paper to be read this afternoon is the joint product of Mr. Watkins and Mr. Comer. Mr. Comer has some work in process which hasn't been completed yet. Mr. Watkins, however, will present the work in its present state of completion.

About the only excuse for forecasting and talking about forecasting is that we have to do it. Nobody does it with any high degree of accuracy. It is still in the stage of guess and yet everybody has to operate on the basis of forecasts. The problem, therefore, is one which requires attention and deserves attention and is getting attention; and after all, if economic analysis doesn't get to the point where you can see a little ahead, see the relation between the factors that are in operation, it isn't worth much.

It is very much easier to give an explanation of how something happened after it happened than it is to understand before, to see the drift of things and prepare to meet them. I am disposed to admit all the shortcomings that exist in this whole question of forecasting, and at the same time, work and be interested in all the progress along that line.

Mr. Ralph J. Watkins: Mr. Bell and gentlemen, I think that I had better protect myself by saying that the title of this paper is "The Relation Between Industrial Employment and Department Store Sales in Ohio."

The problem of forecasting retail trade in a given area is the problem of forecasting the purchasing power of the inhabitants of that area. It is fairly evident that the fluctuations of purchasing power will be reflected in the oscillations of retail trade. The time relationship between these fluctuations will be taken up presently. Increases in purchasing power represent increases in the production of goods and services; that is, increased production means increased command over the articles of production. It is logical to assume that this increased command over present goods will be exercised. It may be countered that many individuals will not exercise this command over present goods but will "save." The answer to this is that all goods are either consumed or are wasted. The saving process is merely a shifting of command over goods from one individual to another. Therefore, the saving element need not be considered. Increases in purchasing power will be reflected in increases in retail trade. Department store sales, the subject of this study, constitute the most general index of retail trade available. It is true that food is not usually adequately represented in department store sales but this is not serious since food expenditures are probably not subject to the same degree of variation as other expenditures. With reference to the time relationship, it has been stated within the past year that purchasing power leads retail trade by six months. On the other hand, Jordan in "Business Forecasting" states that increases in purchasing power are utilized almost immediately. This will be referred to again shortly.

It is obvious that this statement of the problem is no solution. However, the statement does clarify the problem since we know that our efforts must be directed toward the anticipation of changes in purchasing power.

In a highly industrialized region such as the state of Ohio it is fairly clear that industrial purchasing power furnishes the best index of total purchasing power. National agricultural conditions are probably of more importance than local agricultural conditions. This is especially true when one is considering purchasing power in relation to department store sales since the available data represent sales in the larger cities.

There is available in the Bureau of Business Research an index of industrial employment in the State of Ohio. This index covers four very significant industries. These are: general contracting, foundries and machine shops, steel works and rolling mills, and blast furnaces. It has been demonstrated in the Bureau that the index of employment by general contracting firms represents very accurately employment by all construction firms. In brief, the general contracting index is an all construction index in Ohio. It has been further demonstrated that the combined indices of the three mentioned divisions of the iron and steel industry, properly weighted, afford an index of employment for the entire iron and steel industry in Ohio. It will be recognized at once than an index which accurately measures employment changes in these two industries is very significant. The iron and steel group is the largest group of industries in the state, accounting in 1923 for 26.8 per cent of all the wage and salary payments reported to the Ohio Division of Labor Statistics. The construction group is the third most important group in the state, accounting in 1923 for 6.8 per cent of all the wage and salary payments similarly reported. The two groups, then, in 1923 represented 33.6 per cent of all the wage and salary payments reported to the Ohio Division of Labor Statistics. It should be mentioned here that the reports of the Ohio Division of Labor Statistics represent all employing industries except interstate railroads, and individual returns are required of all concerns normally employing five or more persons. The index of industrial employment is based on these two groups of industries, representing as indicated, one-third of the industrial purchasing power of the state. The indices representing the individual industries are weighted in the following proportions: foundries and machine shops 37 per cent, steel works and rolling mills 32 per cent, blast furnaces 6 per cent, and construction 25 per cent. The total wage and salary payments disbursed in 1923, the base year, constitute the basis for these weights.

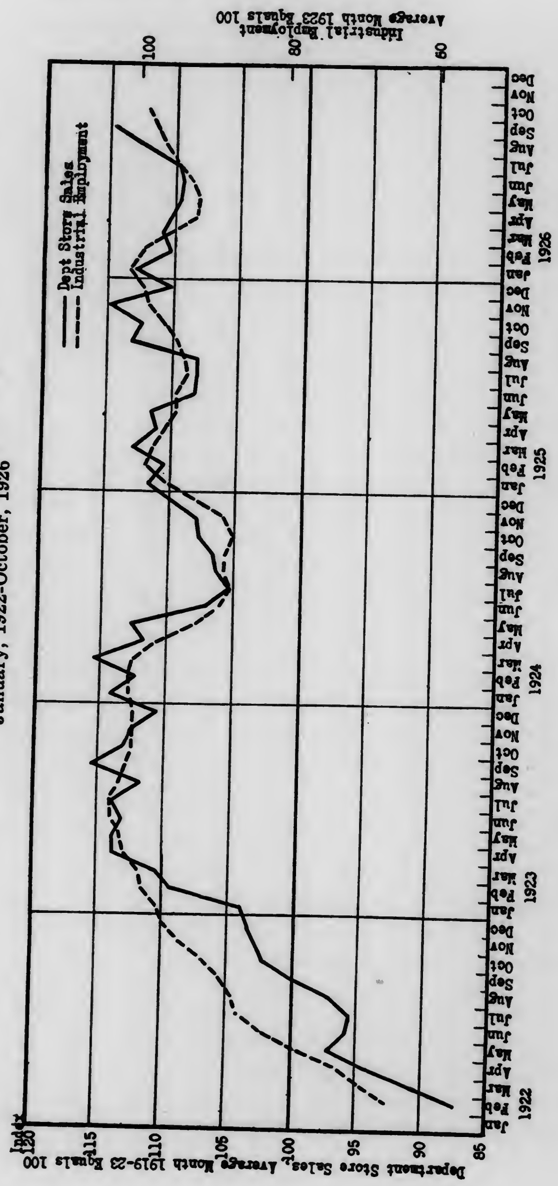
This index of industrial employment is significant not only because of the absolute importance of these two groups but also because of their basic character. In a highly industrialized and highly urban area such as the State of Ohio, it is evident that construction and iron and steel are fundamental in their relation to the economic life of the entire state. This index is available from January, 1922, to date and will be referred to presently. It is the broken line on Chart I.

Since there is available in Ohio a representative index of industrial employment, it becomes possible to test the relationship between industrial purchasing power and department store sales. It is frankly recognized, of course, that the period of observation is a very short one and, therefore, care must be exercised in drawing conclusions. For the purpose of this report, the only available index of department tsore sales has been the index of sales in the Cleveland Federal Reserve District. This district includes Pittsburgh and New Castle, Pennsylvania, and Wheeling, West Virginia.

CHART I

OHIO INDUSTRIAL EMPLOYMENT AND CLEVELAND DISTRICT DEPARTMENT STORE SALES

Seasonally Corrected—3 Months Moving Average
January, 1922-October, 1926



However, these cities belong to the same general economic region and the exclusion of their data should not materially change the results. Parenthetically, it may be stated that an index of department store sales in Ohio alone is now available and at a later time this series will be substituted for the Cleveland District series. The relationship between this series and the Cleveland District series is so close that the results will not vary much.

After plotting the employment index and the sales index, it became evident that there was fairly close quantitative relationship between their fluctuations. They are shown on the chart. I shall refer to them presently. Inspection of the chart likewise pointed to a very close concurrent time relationship. In order to test quantitatively this relationship, the simple correlation between the two series has been determined.

It should be stated here that the two series have been corrected for normal seasonal variation and further smoothed by a three-months moving average. In the case of the employment index, the only constituent series requiring seasonal correction was the construction employment series. This series was corrected before being combined with the other three series into the composite index of industrial employment. This composite index yielded a very smooth curve but it was further smoothed by the three-period average to conform with the department store index. The seasonal index used for this correction was one which was developed by the Bureau based on the period 1914-1924 and is published in the Bureau's study of the construction industry in Ohio. The department store index was corrected seasonally by an index of seasonal variation computed by the median-ratio-to-trend method and is available here for inspection. This correction did not yield a sufficiently smooth curve and additional smoothing was accomplished by the use of a three-period average. The reason for this lack of smoothing is very evident to any student of retail trade and inheres in the use of any uniform seasonal index. The seasonal variation in retail trade varies because of variations in weather, particularly in the spring and fall months, variations in the number of business days, and variation in the time of occurrence of Easter. No attempt has been made to correct the series for secular trend because of the short period of observation and because of the absence of any definite upward or downward trend in this period when it is remembered that the series begin in a year of recovery. Attention is called to the curves on Chart I representing these two series as described.

As already indicated, the broken curve is the curve representing industrial employment in this state based on the construction industry and the iron and steel industry. The solid curve represents the index of department store sales in the Cleveland Federal Reserve District. Each series has been corrected for normal seasonal variation and further smoothed by a three-period moving average. Of course, the effect of the use of these three-period averages is to reduce the scatter about the regression line, but the regression itself is not affected. It is apparent from the chart that there is fairly close quantitative relationship and close concurrent time relationship in the fluctuations of the two curves. I may say that the two scales are shifted in order to throw the two series together. The department store sales index you are familiar with. It is an index based on the average month of the period 1919-1923 as a base or 100; the industrial employment curve is likewise plotted from an index number series, the base being the average month of 1923.

What does the simple correlation of these two series reveal? The results are listed in Table I. The concurrent fluctuations yielded a correlation coefficient of .894 with a standard error of estimate of 2.89. The unit, of course, is the index number of department store sales. Allowing a lead of the employment index of one month, the correlation coefficient was increased to .900 and the standard error of estimate was reduced to 2.54. Proceeding further and allowing a lead of two months to the employment index, the correlation coefficient dropped to .893 and the standard error of estimate became 2.41. The explanation of this drop in the standard error accompanying a drop in the correlation coefficient is to be found in the dependent variable itself. It happens that the first three items in the dependent series deviate unusually from the mean, with the result that the standard deviation of the series is reduced when these items are dropped. Which, of course, points further to the fact that we must be very particular in drawing deductions from such a short period when the exclusion of three items can change the standard deviation so much. Allowing a lead of three months to the independent variable, the correlation coefficient dropped to .844 and the standard error increased to 2.69.

TABLE I—CORRELATION RESULTS

Time Sequence	Coefficient of Correlation	Error of Estimate
Concurrent..............................	.893	2.89
1 Month Lag (Trade)..................	.893	2.89
2 Month Lag (Trade)..................	.894	2.41

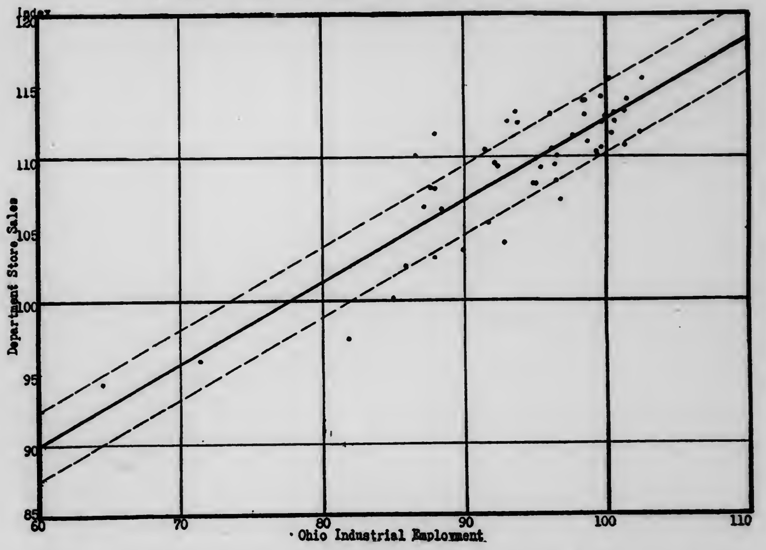
CHART II

SCATTER DIAGRAM

OHIO INDUSTRIAL EMPLOYMENT AND CLEVELAND DISTRICT DEPARTMENT STORE SALES

Both Series Seasonally Corrected
January, 1922, to September, 1926

Regression Equation $y = 55.81 + .569\,x$; $S = 2.41$



It is evident from Chart II that one is justified in using the two months lead relationship even though the correlation coefficient is slightly smaller because of the advantage of an additional month in the forecast. The scatter diagram represents the relationship between these two series when the independent variable (industrial employment) leads by two months. The scatter diagram satisfies the theoretical relationship since more than the required 68 per cent of the dots fall within the zone of estimate, that is, one standard error on either side of the regression line.

Now, note, please, that zero is not the point of origin shown on the chart although, of course, zero is the point of origin for the values. The employment scale begins at 60 and proceeds to 110. The department store sale scale begins at 85 and proceeds to 115. The heavy black line represents the regression line. The light lines on either side of the regression line indicate the zone of estimate, that is, one standard error on either side of the regression line. Of course, since the scales are as they are, the chart may appear to show a poorer relationship than that which actually exists.

Chart III shows the estimated sales and actual sales when the forecasting is done two months ahead. The seasonal factor, you will note, has been re-introduced in the estimated sales curve. I am sorry we do not have the computation of the standard error involved here. It will be somewhat different from the standard error already referred to because in that case we used a three-months moving average and in this case the estimated sales are computed from the actual forecaster each month. The seasonal factor was re-introduced in the estimate by multiplying the estimate of sales by the seasonal index. You will note from the chart that this forecast gives a curve which is very similar to the actual series. The solid curve represents the actual department store sales as announced by the Cleveland Federal Reserve Bank and the broken curve shows the forecast.

Now, what conclusions may be drawn from this study? It is evident that over this short period the fluctuations of these two series are very closely related and are substantially synchronous. In other words, we have the quantitative reply to the question as to the relationship between purchasing power and department store sales, assuming reasonably that the industrial employment curve does represent the fluctuations of buying power in this highly industrialized state.

A second conclusion is that industrial employment constitutes a fairly reliable short time forecaster of department store sales. Now that, of course, appears to conflict with the previous statement. However, by allowing a lead of two months in the independent variable, the correlation coefficient drops only slightly from .894 for the concurrent fluctuations to .893. We are then

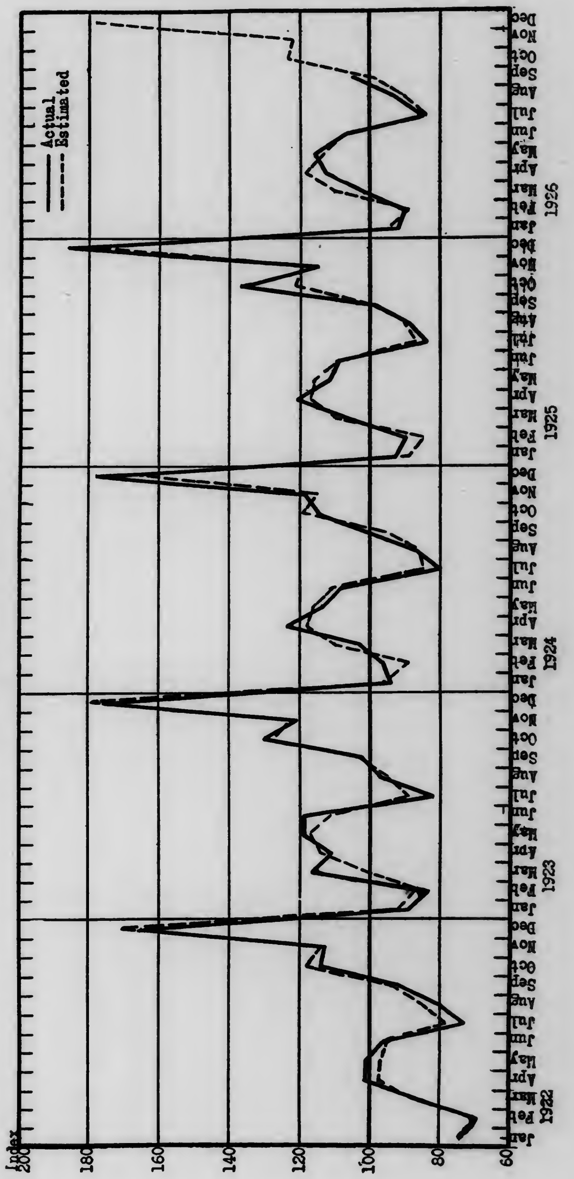
CHART III

CLEVELAND DISTRICT DEPARTMENT STORE SALES

Actual and Estimated

January, 1922-September, 1926

Average Month 1919-1923 Equals 100



justified in using the two months lead relationship because of the additional advantage of the two months lead.

It is, furthermore, evident that our problem is to search for the factors which contribute to changes in industrial employment in Ohio. It may be countered that this much of the problem was known in advance of this study. However, it is fair to say that this study of the relationship between these series does very materially narrow the problem, since the search for these factors may be confined to a search for factors which contribute to the fluctuations in construction and iron and steel employment. It is also reasonable to state that the results of this study can be materially bettered by improving on the seasonal index which is used in correcting department store sales for the reasons which were suggested earlier, that is, the difficulty that inheres in the use of a uniform seasonal index because of variations in the seasonal movement from year to year due to a number of these factors which were mentioned, in particular the weather factor.

It must also be frankly acknowledged that no attempt has been made here to take into account the changes in the prices of department store goods. The Federal Reserve index is, of course, based on dollar sales and these dollar sales are influenced by changes in department store prices. It is extremely unfortunate that there exists no index of department store prices. The variety of goods handled and the constant changes in the character of these goods render such an index almost impossible. The only reliable retail index available is an index of the cost of living and while there are some reasons for the use of such an index in deflating department store figures, they are more or less empirical reasons.

The continuation of the study which is going on in the Bureau of Business Research is taking the form of searching for advance indicators of the employment changes in the key industries of construction and iron and steel. This has proceeded to the point where we may announce three of these: national pig iron production, construction contracts awarded in Ohio, and an index of help wanted requests from employers. This last named index has recently been computed in the Bureau on the basis of data supplied by the Ohio Department of Industrial Relations. It is hoped to secure some additional variables and the solution will take the form of a study in multiple correlation. In view of this continuation of the problem, any criticisms of methods employed will be welcome.

I have here some additional notes which have a bearing on this problem which I want to read. This is the joint work of myself and my colleague on forecasting a line by itself, taking the application from this particular study.

In the standard works on the correlation of time series, it is assumed that there is only one standard of comparison in gauging the value of a correlation coefficient. That standard is the comparison between the standard error of estimate and the standard deviation of the dependent series. The arithmetic mean of the dependent variable is taken as the most probable value in the absence of any other forecast and the standard deviation of the series becomes the measure of the error of estimate. But, it is evident that the mean of a time series is a fictitious estimate since it cannot be known until after the actual value for which a forecast is desired becomes available. In actual business practice, no business man knows anything about the mean of his series even up to the present. However, he does have a basis from which to estimate the future value of his series, and that is the present value of that series, a perfectly concrete and comprehended value.

There is a certain stability to any economic series and its fluctuations are measured from the present level as a base. The present value represents not only present conditions but the cumulative effect of past conditions in so far as those past conditions influence the present. The price of corn today, for example, is the cumulative effect of past conditions plus present conditions of supply and demand in the corn market.

Then, what is the basis for estimating a series, taking into account this stability of the series? Merely this: assume no change at all in the series, i. e., project the series horizontally from its present level and there is available a ready measure of the error involved in such a process. This is the average change in the series itself for a period equal to the period of the forecast. If we desire to forecast retail trade one month in advance, then we find the average month-to-month change in the retail trade series. In order to secure a measure comparable with the standard deviation, we should compute what might be called the "standard first difference," i. e., we compute the root-mean-square of the month-to-month differences. If this computation yields a standard first difference smaller than the standard deviation, it shows that the last recorded value of the series is a better estimate than the mean of the series. But, what is more important is that this same comparison can be made with the standard error of estimate. If the standard first difference is smaller than the standard error, then the last recorded value of the series affords a better estimate than the regression equation. In other words, variability in the series itself is less than the error in the estimate.

It will be countered that this process begs the whole question of forecasting, which is correct. However, this process does yield a basis for comparison which may be more relevant than comparison with the standard deviation of a time series when short time forecasts are desirable. As a concrete example, we may take our one month estimate of department store sales in Ohio. It will be recalled that the simple correlation coefficient was .900 and the standard error was 2.54. The standard month-to-month difference is only 2.39.

I may say that these other computations are shown in Table II. I have shown first the time interval, next I show what I have called the standard first difference, which is merely the root-mean-square of the differences between the present value and the values one month, or two, or three, or four, or five months later. The standard errors and the standard deviations already referred to are shown next.

Now, of course, the usual comparison is the comparison of the standard error of estimate with the standard deviation of the series itself. If the standard error of estimate is smaller than the standard deviation, it is assumed that the estimating equation gives better results than estimates based on the mean of the series. Likewise we may assume, if the standard first difference is smaller than the standard error of estimate that the average error would have been smaller had we assumed no change at all. That is the situation here when we are estimating sales one month in advance.

Now, the whole point of this is that for a short time forecast we have a better basis of comparison in the standard first difference than in the standard deviation, the standard deviation representing the error involved in estimating on the basis of the mean of the series itself taken as the most probable value and the standard first difference representing the error involved in estimating one month in advance on the assumption of no change at all. A forecast of no change at all would have yielded a smaller error over this period since January, 1922. The standard deviation in the series is 5.84. It is clear here that we have a better basis for comparison in the standard first difference of the series.

When we go beyond a one-month forecast, the regression equation based on industrial employment as the independent variable yields better results, as would be expected. That is, the standard first difference increases and is much larger than the standard error of estimate. The results are shown in Table II.

TABLE II—MEASURES OF COMPARISON

Time Interval or Lead	r	S_y	$S_{\Delta y}$	σy
1 Month....................	.900	2.54	2.39	5.84
2 Month....................	.893	2.41	3.06	5.36
3 Month....................	.844	2.69	4.17	5.01*
4 Month....................	....	....	4.57	....
5 Month....................	....	....	5.26	....

* The changes in the standard deviation are due to the dropping of the first items which deviate unusually from the mean. The 5.01 value is the most reasonable value for comparison purposes.

When does this comparison of the standard error with the standard first difference cease to be significant? The answer is to be found in the comparison of the standard first difference with the standard deviation. When the standard first difference becomes larger than the standard deviation, estimates based on the mean of the series will yield more accurate results than estimates based on the last recorded value. Now, the whole effect of this procedure is to give an additional basis for comparison in measuring the significance of correlation.

There is another use to which this concept may be put. If we wish in our forecast to give weight to the stability of the series itself, we can accomplish this by injecting the series itself as an additional independent variable and handle the problem by multiple correlation. An example will illustrate. In the retail trade study, allowing a lead of two months to industrial employment, a simple correlation coefficient of .893 was secured and the standard error of estimate about the line of regression was 2.41. The series itself two months earlier was injected as a third variable and the coefficient of multiple correlation became .914 and the standard error of estimate was lowered to 2.17. Thus a distinct improvement is made in the forecast by considering only the stability of the series itself. The injection of the additional variable without an increase in the number of items, of course, reduces the reliability of the coefficient of multiple correlation; however, this reduction is more than offset by the increase in the coefficient.

It is evident that this approach to the problem has distinct limitations. If the forecast is for more than a few months ahead, the standard first difference of the series is apt to be so large that it should be possible to secure an outside series which will show a closer relationship. The comparison of the standard first difference and the standard error will reveal this condition.

There is another consideration in connection with forecasting a line by itself which should be presented here. This is the relation between a centered 12 months' moving average and a sliding 12 months' moving average. It is obvious, if these two averages relate to the same series, that the movements of the centered average will precede by six months the movements of the sliding average. It is further obvious that the same result will be secured by using the two averages of different but concurrent series. For example, a centered 12 months' moving average of bank debits will precede by six months a sliding 12 months' average of department store sales.

Another point in connection with the use of 12 months' sliding averages or totals should be pointed out. The forecasting of such totals six months in advance throws a smoke screen about the margin of error involved. If we stand at July 1st and are faced with the necessity of forecasting a 12 months' total as of December 31st, we have six of the 12 monthly totals involved. Hence, we can make a large error in estimating the remaining six months and still make a relatively small error in forecasting the 12 months' total. For example, we could assume no change in the last six months of the year over the same period of the previous year. The resulting error involved in forecasting the 12 months' total would probably be relatively small. This is commonly overlooked. It does not mean that such 12 months' sliding totals are not useful. On the contrary, they represent the simplest method of showing the combined influence of trend and cyclical movements.

Chairman Bell: Are there any questions that any one would like to ask Mr. Watkins about this paper?

Question: I would like to ask a question about those employment figures of the number of men employed. Has there been any attempt to get wages?

Mr. Watkins: We only have annual averages prior to this year. It would be desirable to have that but it wasn't available.

Mr. Hoagland: Does that represent the number employed?

Mr. Watkins: The figure we get represents the average number of full-time wage earners employed.

Mr. Hoagland: Are you sure enough of your reports that you get full time?

Mr. Watkins: You can't be absolutely sure. There is doubtless a considerable margin of error involved but I should say that prior to 1926 these figures have been secured from the Ohio Division of Labor Statistics and currently the figures come to the Bureau by cooperation with the individual employers.

Dr. Hardy: In regard to construction employment, shouldn't the variations due to seasonal employment have a relation to department store sales?

Mr. Watkins: It is probably true that these wage earners have adjusted their expenditures to take into account the seasonal movement. Of course, you get a very distinct seasonal movement in construction employment, very low at the beginning of the year and coming to a peak in August and September and down again at the end of the year. That is about the curve you get.

Dr. Hardy: I suppose what takes place is a partial adjustment.

Mr. Watkins: It seems logical to correct that series because you get such a pronounced curve and get it every year. That curve hasn't been smoothed out.

Dr. Hardy: It would be interesting to see how much adjustment they do make.

Mr. Watkins: I could introduce that series as it stands.

Question: On the index of industrial employment, will you give us an explanation for the downward drift this year?

Mr. Watkins: I think there is one explanation which again points to the danger of using the limited series and that is the prevalence of strikes in the building industry in Ohio in 1926. Of course, you may say that deprives those wage earners of employment, but we are not sure that they don't get employment in some other industry.

Question: What are the series that anticipate the changes in employment.

Mr. Watkins: National pig iron production, construction contracts awarded in Ohio, and an index of help wanted requests from employers. We have worked up this last series from material available from the Ohio Department of Industrial Relations. The fluctuations in that curve are greater than the fluctuations in the actual employment curve. The employers who feel that they are going to need additions to their forces are apt to make more requests than they have places actually available, and that curve seems to precede the employment curve by several months.

Dr. Merchant: Are those things available from the employment bureaus?

Mr. Watkins: The figures are furnished us by the State-City Employment Service. I think that is operated by the National Government, the State Government, and certain cities.

Question: That doesn't affect industrial employment so much as farm employment, does it?

Mr. Watkins: Farm employment is a very small item. The figures are classified as between skilled labor and unskilled labor and clerical work and so on. The industrial labor figures are used.

I should like to hear some discussion on the other basis of comparison presented here. These figures are my own. The idea is my colleague's.

Mr. Smith: There is one question which occurred to me in comparing the standard first difference and the standard error of estimate and that is whether or not the change in the forecasting curve compares with anything. Now, the method you have employed does not take into account that other factor and it seems it could be introduced. I can visualize the situation with two curves where the standard error of estimate would be large compared with the standard first difference.

Mr. Watkins: We thought of this point: Suppose, for instance, that we stand at a given level and the forecast based on our regression equation is a point considerably below or considerably above. Let us suppose that this zone is the zone described by the standard first difference, 2.3 above and below the given level, and that the estimated value lies outside this zone. I should say in that case that your estimating equation is apt to give you a more logical figure than the present level since your forecast is for a definite turn. I am not sure that this is the point you raised, however.

Mr. Smith: Perhaps I might make the suggestion clearer by saying there are three independents to be used in forecasting. The first would be the actual level, the dependent at a given date. The second would be the actual forecast, and the third one would be the change of the forecast over the preceding forecast so you are carrying first differences and one absolute level.

Mr. Watkins: Of course you are not limited to this one interval. You can introduce as a fourth variable the dependent series three or more months earlier. The thing that I think you have in mind could be tested by scoring the forecaster as to accuracy in direction only. If it were true that considerably over half of the forecasts were right as to direction, then we should be justified in using the forecaster even though the standard error were greater than the standard first difference.

FORECASTING GENERAL BUSINESS CONDITIONS

By

C. C. Morris, Professor of Mathematics, Ohio State University

Chairman Bell: Professor Morris has been interested for a number of years in the question of forecasting price trends in wholesale and retail trade and has done some of this work professionally as well as working on it theoretically in his mathematical work and he has consented to discuss this afternoon some of the results of his work.

Professor Morris: As our Chairman, Mr. Bell, has suggested, I have for a number of years been interested in the application of statistical methods to economic data. I have been especially interested in the problem of forecasting, and the study which I am to give you this afternoon is a mathematical approach to this most interesting problem.

If you should ask a business man what is business, he probably would define it in terms of buying and selling. He probably would say that business is good if his buying and selling was resulting in satisfactory profits, and bad, if his buying and selling was resulting in losses. For my purpose, I will give a new definition of business. I will say that business is a relationship between prices and interest rates on the one hand, and a relationship between production and interest rates on the other. I will also say that business is good when prices and production are high compared to interest rates, and bad when prices and production are low compared to interest rates. This dual definition of business is an abstract one, but it is quantitative in terms of the relationships designated. The value of such a definition lies in the fact that when the values so determined are plotted the curve agrees very closely with the standard curves for the volume of business, but runs well ahead of them.

It is a matter of experience that business changes with time. Business is therefore a function of time. We may write

$$B = F\ (t)$$

If the time rate of change of a dependent variable can be determined, the explicit form of the function can be obtained at once

by the process of integration. In this particular case we can only make assumptions regarding the form of the derivative. The validity of these assumptions can, however, be tested by comparing the conclusions drawn from them with those of standard business series. We will assume that: $\frac{dt}{dB} = F\ (\textit{prices, interest rates})^{k_1 t} + F_2\ (\textit{industrial production, interest rates})^{k_2 t} + (\textit{total consumption---total production})$.

In the first term of this derivative, the Harvard 10-commodity, and the Harvard 4 to 6 months good paper, indices were used when passing from the trough to the crest of the business cycle; when passing from the crest to the trough, Bradstreet's index of prices, and the Harvard call money index, were used. The form of the function joining prices and interest rates, together with the constants involved, may be found by conventional least square methods. As the prosperity phase of the cycle is approached, it was found desirable to have a sensitive or fast moving index for prices and a slow moving index for interest rates. As the depression phase of the cycle is approached, it was found desirable to have a slow moving price index and a fast moving interest index. The two composite series are kept up to date, the end of the prosperity phase of the cycle being clearly indicated when the second series, having overtaken the first, begins to decline.

In the second term of the derivative, the Harvard index of manufacturing production was used for the first, and the Harvard 4 to 6 months good paper for the second series. Since the Harvard production series is corrected for seasonal variation and trend, the interest series was corrected for seasonal variation. No attempt was made to correct the interest series for trend, its slight downward trend since 1919 being neglected. Least square methods were used to find the relation between the two series, an interesting device being first used to reduce the degree of the equation.

The third term of the derivative, which is independent of t, has proven to be the most troublesome part of the assumption. So far as I know there is no total consumption series. The Harvard Bureau publishes a total production series, a composite of mining, agricultural, and manufacturing production. No satisfactory substitute for a consumption series, comparable to that of Harvard for production, has been found. There seems to be no doubt however but that business responds to over or under production, and that when these two factors are not in equilibrium, the effect upon business is immediate. A series to measure the discrepancy between consumption and production is highly desirable.

The similarity between the assumptions made in writing the value of $\frac{dB}{dt}$ and those made by Gompertz and Makeham in their study of the law of mortality is evident. Gompertz assumed that the rate at which people die is proportional to their age. Here it is assumed that the rate at which business changes is proportional to business itself. Such assumptions lead directly to exponential functions. Makeham added a term to take care of deaths due to causes other than that of age. The third term in the derivative was here added to take care of those more or less accidental factors which affect business.

The application of the formula $\frac{dB}{dt}$ to the problem of forecasting involved many difficulties. Two of these, "normal" and "correction for seasonal variation," will be discussed at some length. When the word "normal" is used in statistical studies, we usually think of an average over a term of years. A rate of growth is said to be normal if it is equal to the average rate of growth. The word "base" is often used instead of the word "normal." In any case the normal or base is something fixed. In a study such as is undertaken here, we must have a variable normal, a normal which changes with the habits of people and their methods of living. What do we mean when we speak of the normal rate of building? Some of our statisticians are now trying to make up their minds as to whether or not the deficit in building accumulated during war times has been made up. They forget that our habits of living have greatly changed. Before the war, we thought that that rate of building was normal which provided every family with a home. Now, however, a large portion of our population insists upon having two homes, one in the city for the winter, and one in the country for the summer. A third home at the sea shore, at a northern woods is a necessity for the man who attempts to live two years in every calendar year. Not one home but two or more for many families is making our normal rate of building a changing one. The same situation is met when we study the automobile series. A car for every family seemed to forecast the saturation point. But here also our habits of living are changing. Father must have a car to go to his office, mother one to go to her parties, and the children one to go to school. When I went to college 30 years ago, we thought a father was doing his duty if he supplied board, room, and clothes for his son. But now the collegiate car is as much a necessity of the student's equipment as a pair of shoes in my day. What I am trying to say is simply this: that any base or normal that we may choose from which to measure our deviations must be a changing base or normal. A normal based upon the past will likely give false impressions as to what is happening at the present time. Certain arbitrary corrections in the calculated trend are often necessary.

The problem of forecasting demands new methods for determining the seasonal variation. The statistician who is studying the building series finds that his seasonal coefficients for the early spring months are gradually falling and those for the early fall months gradually rising. The spring peak each year is not quite so high as the spring peak of the preceding year, while the fall peak is higher. New methods of building foundations and laying brick in freezing weather are being used. This change is reflected in the values of the seasonal coefficients. There is a distinct trend here and cyclical variations as well. The same is true of the automobile series. Before the advent of the closed model, the bulk of the spring sales of new cars took place after good weather set in. Such sales are now made in January or February. This change has brought about a distinct trend in the seasonal coefficients. A consideration of these facts brought me face to face with the problem of devising a method of calculating seasonal coefficients which would take account of trend and cyclical variations in the coefficients themselves. Another consideration was also present. In forecasting we regard the end of each month as the end of a year, and we are not so much concerned as to the part the month will play in the calendar year as to the part it did play in the year of which it is the twelfth month. A knowledge of this part is our guide as to the part it will play in the following year in which it again is the twelfth month. To meet all these considerations the following method was devised:

(a) A twelve-months' moving average centered on the twelfth month.

(b) The averages for each month were considered separately.

(c) A straight line was fitted to each of these twelve sets of averages taken in their proper order.

(d) A curve $y=a_0+a_1 \sin x+a_2 \sin 2x+a_3 \sin 3x+b_0 + b_1 \cos x + b_2 \cos 2x + b_3 \cos 3x$ was fitted to each of the twelve sets.

(e) The intersection of the straight line and the curve for each set gives the seasonal variation for the month in question.

It may be noted that the sum of the seasonal coefficients thus determined is not necessarily twelve hundred. We are no longer interested in the seasonal coefficients of the calendar year.

The diagram which follows is a copy of one of the study sheets used in forecasting wholesale trade. The Harvard B curve is also given. The reading for January, 1919, of the forecasting curve is plotted against that for July, 1919, of the Harvard B curve. This gives the forecasting curve a lead of six months. It will be noticed that the depression of 1924 was signaled in July of 1923 and the great expansion of business of 1925 was signaled in August of 1924. If the forecasting curve does as well in the future as it has done in the past, the prospect for October, November, and December is not as good as was the prospect for these months a year ago. It appears that we shall go into the new year with a gradually falling commodity price level, and a gradual shrinking of the volume of business. This does not mean that we may expect a serious shrinkage of business in 1927. The forecasting curve is still above normal, and normal makes provision for a definite growth. In conclusion it may be remarked that it seems significant that business defined from the abstract point of view here taken should, when plotted, agree so closely with one of the standard series for the volume of business and anticipate this volume series by six months.

NOTE: There were several questions asked in regard to Prof. Morris' paper. In order to economize space the editors condensed the pertinent questions in regard to his method as follows:

1. Inasmuch as the author concedes that the third term in his derivative equation was not used because of inability to secure measures of consumption, why should this term be included in the equation?

2. Inasmuch as this third term is not used, what is the equation which is actually employed?

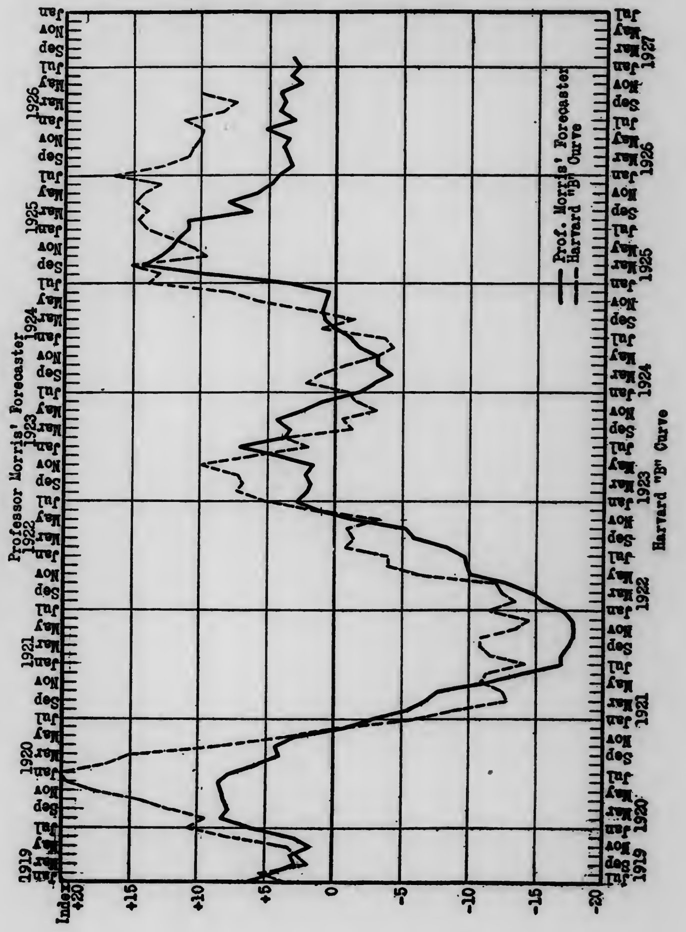
3. What is the precise method of securing values for the derivative and how are these derivatives translated in terms of standard deviations as finally

plotted on the chart? It is suggested that the question could be answered by showing the method of securing a value for one month only.

4. Since fast moving indices are used on the down-turn and slow moving indices are used on the up-turn, what is the signal for transferring from one

PROFESSOR MORRIS' FORECASTER AND HARVARD "B" CURVE

January, 1919, to August, 1926



to the other? The author stated in response to a question that this was determined by setting the derivative of the curve at zero. This is applicable in case the function of the curve is known in advance, but how can this be employed when the whole problem is to determine changes in the curve?

5. Since the technique of determining indices of seasonal variations makes no reference to index numbers, how are seasonal index numbers determined from the method as outlined?

6. Is it not true that the use of 12 months moving averages sets up composite normals rather than indices of seasonal variation?

7. How can the use of a cycle in seasonal indices be justified with the concept of seasonality, which concept is of a seasonal curve which recurs year after year in a similar manner or else changes its direction with consistency due to changes in the factors responsible for seasonality?

8. Do the straight line and the curve intersect once only for each set of values? Number (e) in the author's manuscript states that the intersection for each set gives the seasonal variation for the month in question. Is it not true that the two lines would intersect a great number of times for each set?

9. Since no mention of seasonal index numbers was made in the explanation, why would the sum of the so-called seasonal coefficients necessarily be anything like 1200?

10. Would it not be possible to show in a chart just how the seasonal measure is arrived at for a given month or a given set of months such as all the Januarys?

In explanation Professor Morris submitted the following reply:

"The paper presented above is, as you must know, only a preliminary one. Its only purpose was to draw attention to the fact that out of 3 series could be gotten a composite series which greatly resembles the Harvard and Snyder series, the latter a composite of 56 series. Just how the relations are to be found between these three series and what methods are to be used, I am far from sure. I think, however, if some good mathematicians should take hold of the problem they might find an answer to the problem which I have tried to solve.

"The whole matter is in too much of a state of change to go farther at the present time. Quite a number of changes have been made in the last month or so—the new series on production published in the February number of the Federal Reserve Bulletin has improved that series. But a production series going back only to 1919 has many limitations which the future only will make clear.

"The series I sent you is only one of many that I have made. Since the data are usually destroyed as soon as the study is completed, I am not sure just what conditions that particular study was based upon. I think, however, the third term in the formula was not used and a note to that effect should be added."

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